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The Essentials of Rigid Frame Design

Rigid Frame Construction Practically Non-Existent in America—Is Widely Used in Europe—Advantages of This Type of Structure—What Rigid Frame Construction Is and How It Is Used—Examples of Rigid Frame Design

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Part I.

THE uses of reinforced concrete, in this country, are so widespread that one wonders if there are any untried fields remaining and, yet, the rigid frame forms a class of structure that has scarcely been touched by American engineers. So few are the recorded examples of this type of construction that we may conclude it is non-existent in this country. Judging from European engineering literature, structural steel construction is used only for the heaviest types of industrial buildings while the rigid frame of reinforced concrete predominates in the construction of ordinary mill buildings, power houses, theaters and other buildings now spanned by steel roof trusses.

On a competitive basis, there is no reason that the rigid frame should not be as economical, in this country, as the structural steel mill building, except in the cases of standardized steel structures of more or less temporary character. Until our engineers and builders thoroughly understand the design and construction of the rigid frame, its use will probably be limited to such buildings whose owners want this type of structure for the advantage it has to offer. Thirty years ago, a reinforced concrete arch bridge was attempted only by the more competent contractors of that day or, shall we say, the more adventurous ones. In later years, after the general construction practice had been well developed, contractors who would bid on that class of work were no longer in a special class. The rigid frame will probably not have such a difficult struggle to come to the forefront because it is, after all, merely an adaptation of the arch as used for bridge purposes. After the design practice has been well introduced and the form work simplified and standardized, the rigid frame will make rapid progress.

Advantages

In Europe it is scarcely necessary to list the advantages of the rigid frame structure but here it would not be amiss to mention the most important. With the rigid frame, it is possible to carry a roof over long spans where steel roof trusses are now used exclusively. Arched roofs, having clear spans of 100 feet or more, may be readily executed in reinforced concrete. For such long spans, the reinforced concrete girder is well nigh impossible because of the excessive dimensions and weight of such construction. By resorting to the rigid frame principle (i.e., the arch principle) the concrete is subjected to a normal thrust in addition to bending moments, thereby better utilizing the material for the force it is best adapted to resist, viz.: compression. The tensile strength of concrete in the tension zone of a reinforced concrete girder is discounted in the computations of the stresses due to bending at any cross section. Save for its value in resisting shear, it is merely dead weight. To overcome this handicap of excessive weight, the long span reinforced concrete girder must give way to the arch rib with a tie-rod or to the diagonalless truss known as the Vierendeel girder. Thus, any arrangement of the members of a rigid frame by which much and sometimes nearly all of the tension zone of a reinforced concrete section is eliminated introduces an immediate economy of weight and materials.

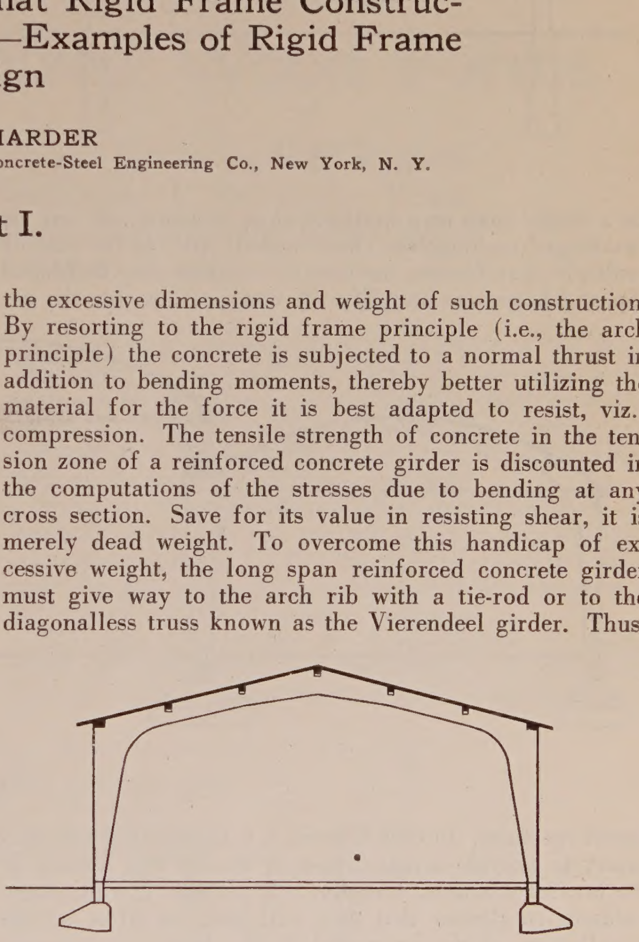


Fig. 1a.

The interior of such structures presents a light and airy appearance. There are no roof trusses to obstruct the light and gather dust and the condensation of moist air. The rigid frame with a hollow tile roof slab would go a long way toward solving the condensation problems of the paper mill engineer and would eliminate some of the temporary arrangements often employed to prevent water and rust from falling on the paper in the machines. In foundries the nuisance of soot and dust collecting on the angles of the roof trusses would be avoided.

What the Rigid Frame Is

Strictly speaking, the rigid frame is an arched structure spanning the width of the building from foundation to foundation. It is a monolithic combination of a curved or polygonal arch supported on vertical columns. It may be a single span or a multiple span structure. It may be two-hinged or hingeless (fixed ended) and, in the case of multiple span frames, the interior columns may be hinged top and bottom to simplify the computations for the external reactions. In such frames, it will not always be necessary to provide actual hinges at the top and bottom of the interior columns. Usually, it is possible to make these columns so slender that they will have no effect on the equalization of the horizontal thrusts from span to span and a negligible effect in the transmission of bending moments from one span to the next.

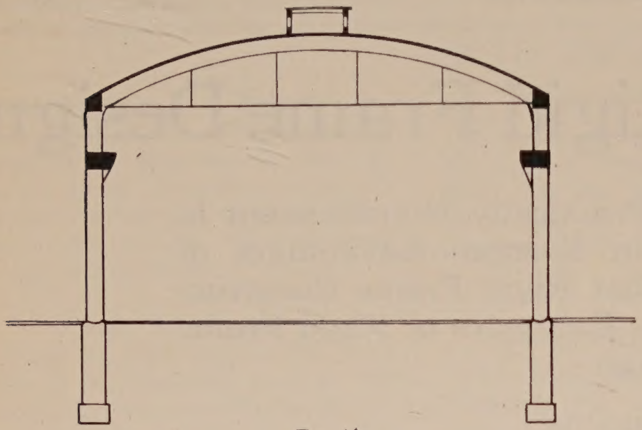


Fig. 1b

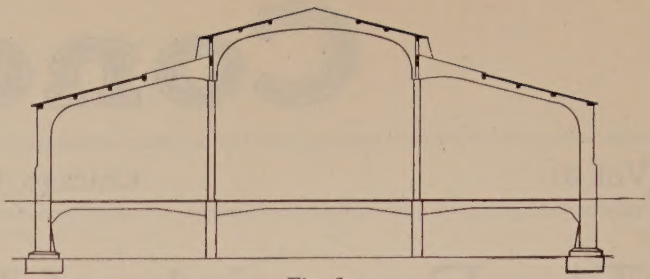


Fig. 1c

The accompanying illustrations show a few selected examples of the rigid frame as it has been built in Europe. Fig. 1*a* shows a simple two-hinged frame; Fig. 1*b*, shows a two-hinged frame with a tie rod at the level of the column tops. Fig. 1*c* shows a multiple span structure in which the end columns are designed to take the horizontal thrust of the entire frame while the interior columns are slender enough to be considered as hinged, top and bottom. Fig. 1*d* shows a three span structure provided with hinges at the bases of the columns and tie-rods across the tops. Fig. 1*e* shows the writer's proposed design of the Bush type of train shed utilizing the principle of multiple spans with flexible interior columns.

Last but not least, may be mentioned the fire resisting qualities of the rigid frame as compared with the steel roof truss. It is really axiomatic that a hot interior fire or, for that matter, an exterior one will cause steel roof trusses to collapse but such possibilities are remote if the rigid frame construction is used. If the interior contents of a building are to be of a highly inflammable character, it would not be advisable to use tie-rods in the rigid frame construction but, if tie-rods are used, they must be properly fireproofed with a concrete covering.

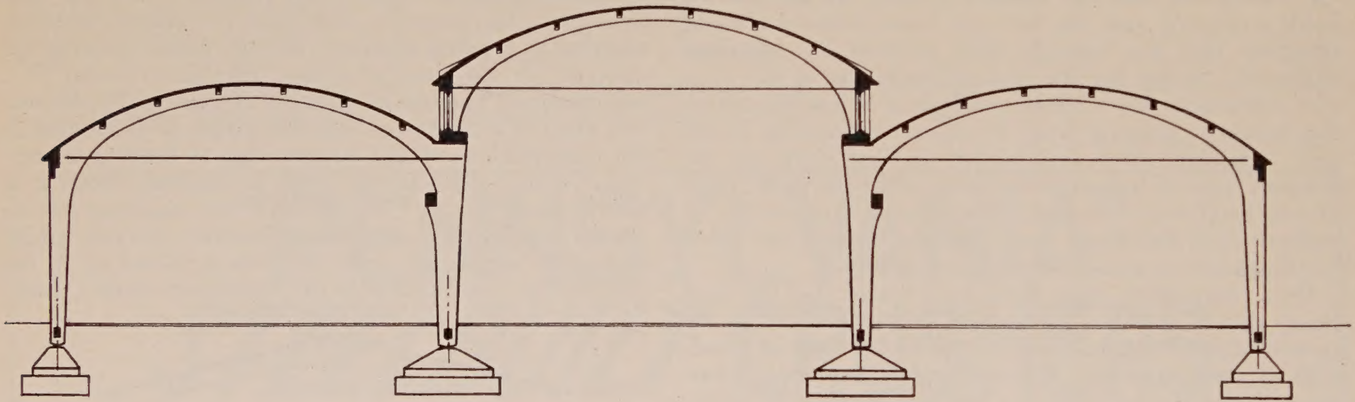


Fig. 1d.

Its Disadvantages

The main disadvantages of the rigid frame are those that

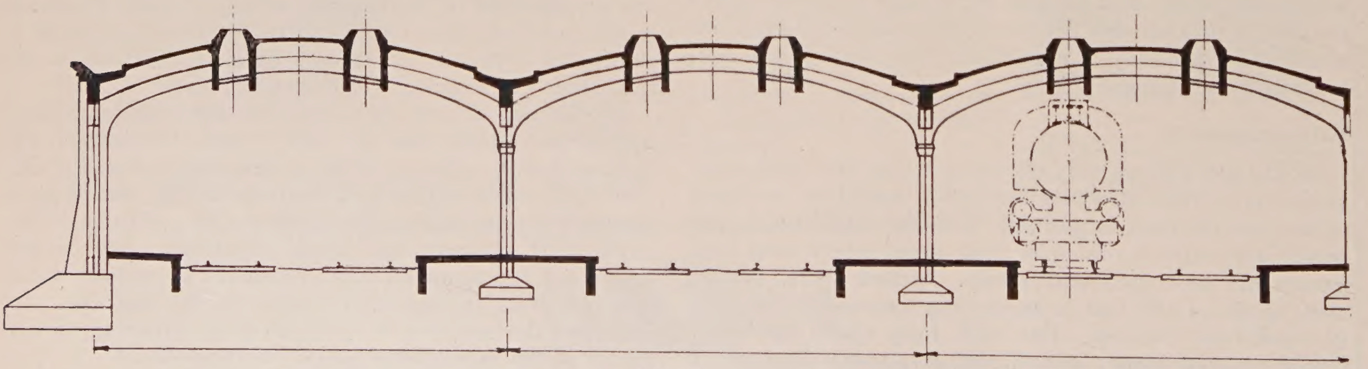


Fig. 1e

attend any indeterminate structure. The foundation must be made as unyielding as possible and, therefore, the rigid frame can be built most cheaply where rock is available and near the surface of the ground. Spread footings can also be used where the foundation is less firm than bed rock and piles are indicated where spread footings alone are insufficient. Of course, expensive footings increase the cost of the structure because the footings must resist a vertical as well as horizontal reaction, but foundation costs can often be ameliorated by the judicious use of tie-rods to take up the thrusts of the arched portion of the frame.

Some engineers may also find the uncertainties of the elastic theory, as applied to reinforced concrete, objectionable. By adhering to the general rules established by European practice, substantial and enduring structures can be built as is attested by European practice of the past 25 or more years. "The proof of the pudding is in the eating thereof," and European engineers have well established the fact that the elastic theory, when safely and sanely applied, will enable one to confidently design reinforced concrete structures which could not be designed by simple methods.

(To be continued)

Reducing Construction Costs By Using Standardized Wood Forms

Use of Standardized Wood Forms Growing—A Typical Standardized Form—How Flexibility Is Secured—Their Use on a Large Job Described—Economies Effected—Comparison of Form Costs

FORMWORK on large and complicated building construction projects can be built economically in a central location and assembled on the job. It matters little whether the form units are made in a carpenter shop and delivered to the building site, or whether they are built on the construction project itself. The fact is that, with sufficient thought and ingenuity, standard wooden form units can be devised that will have the necessary flexibility to meet all requirements, and will at the same time show a definite saving as compared with the more usual methods of building forms.

The last two or three years have seen considerable progress in the development and use of standard wooden form units, more especially in Chicago and vicinity. One large general contracting company in that city, the Avery Brundage Co., has used such forms on nine large buildings, and the McLennan Construction Co. has used similar forms on an equal number of jobs. The Mueller Construction Co., the Math Rauen Co., and others have used them on several of their recent contracts.

From this it appears that another improvement in construction methods is in the making, one that will play its part in offsetting the high construction costs prevailing since the war, and will bring about a further reduction in the cost of reinforced concrete buildings.

It is not surprising that the standardization of wooden forms for all-round use has been developed by specialists. It is far from a simple matter, though it appears simple

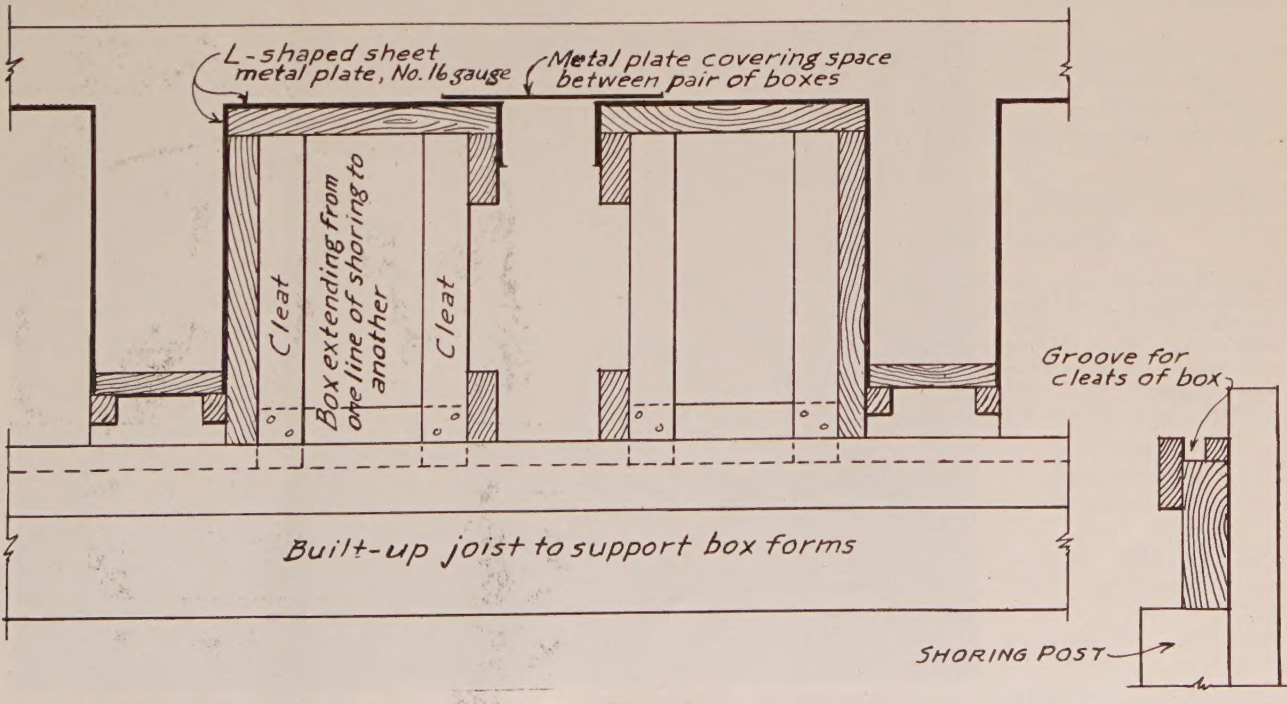

L-shaped sheet metal plate, No. 16 gauge
Metal plate covering space between pair of boxes
Cleat
Box extending from one line of shoring to another
Cleat
Groove for cleats of box
Built-up joist to support box forms
SHORING POST

Figure 1

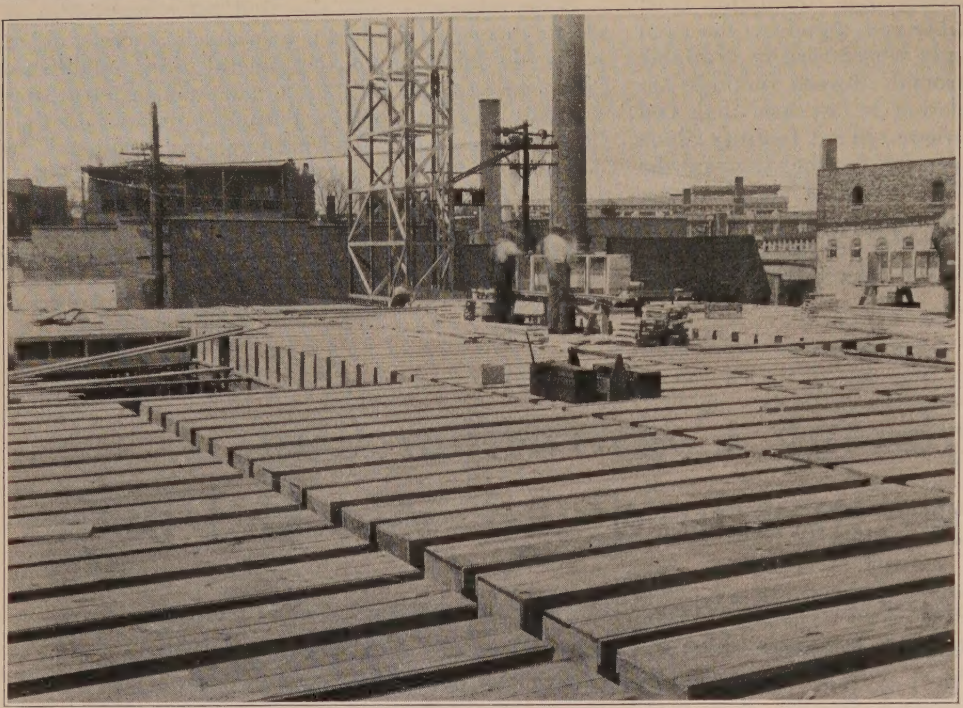


Figure 2. Standard form boxes in place, showing spaces provided for girders and beams. Photo taken in August, 1927, at Wieland Dairy Co. building, Chicago

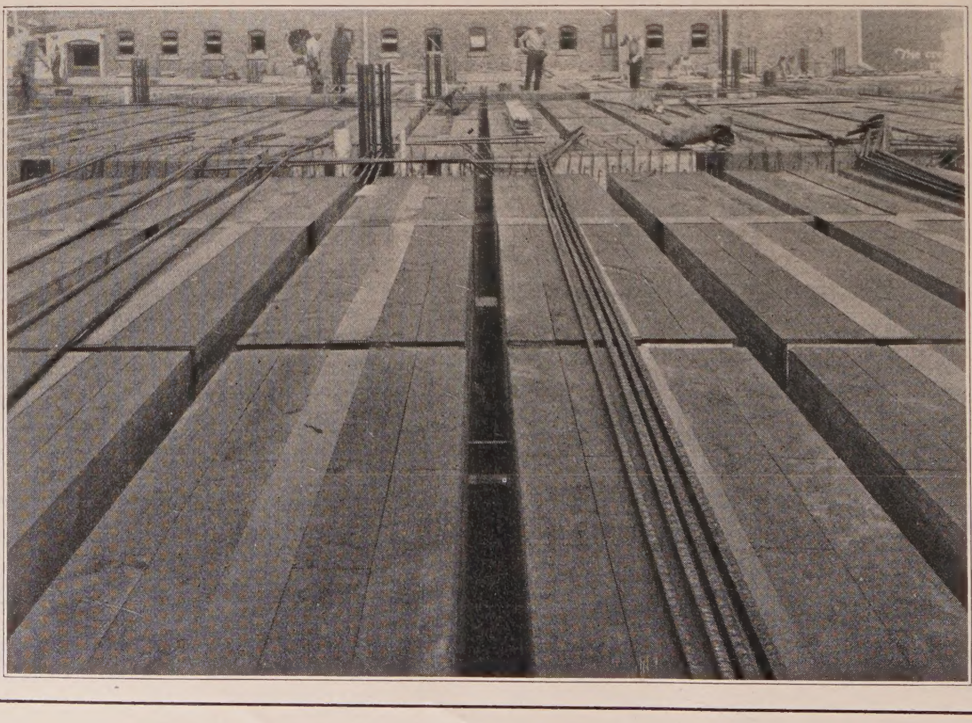
enough after someone with an inventive turn of mind and a practical knowledge of construction has worked it out. Inspection of this standard formwork in actual use, however, is sufficient to convince one that its present state of perfection is the result of painstaking development and gradual improvement. It is not something that can be devised offhand during construction.

Typical Standardized Form

Our line illustration (Figure 1) shows a detailed cross-section through the forms for reinforced concrete beams and floor slab. Minor variations from this detail might have been found on all work where forms of this kind were used; but in its essential details this drawing illustrates the method.

The most prominent feature of this standard formwork is the long wooden box, a pair of which is placed between two concrete beams. The length of a box is a little less than half the length of the floor panel, so that two boxes can be set end to end in each panel, with a short space between them. The short space between ends is bridged over by an L-shaped sheet metal plate of 16-gauge material. This end space, which may be anywhere from several inches to several feet long, permits flexibility in placing the boxes. Flexibility in width is obtained by making the width of each box less than half the clear space between concrete beams, and again putting down a sheet metal plate to bridge the gap between boxes. This plate, as well as the L-shaped plate, may be seen clearly in one of our photographic illustrations (Figure 3).

Figure 3. Showing spaces between standard form boxes covered with No. 16 gauge sheet metal. Note the true alignment of the forms. Photo taken in August, 1927, at the Wieland Dairy Co. building



Forms Are True and Rigid

The boxes are in the nature of built-up beams, capable of supporting the freshly-placed concrete without deflecting or vibrating under load. In consequence of this rigid support of new concrete, workmen may walk on a floor panel 24 hours after the concrete is placed, without damaging the material.

The form joists supporting the boxes usually have two small pieces added, as shown in the cross-section of a joist at the right edge of our line drawing. This detail provides a groove for the cleats of the boxes, and actual mechanical anchorage is obtained. On some jobs these two additional pieces are omitted, the boxes simply resting on the joist. The form joists are supported in turn by the shores, which are made of two pieces arranged in a T-section, one piece being in contact with the form joist and the other being in contact with the form board against the under side of the concrete beam.

When the forms are stripped the shores are left in place as long as necessary. It should be noted, however, that all formwork can be removed without disturbing the shores.

Two photographs, Figures 2 and 3, show the excellent appearance and true alignment obtained with these forms. Figure 2 shows the boxes in place, but no sheet metal strips. Figure 3 shows the metal strips in place and tacked down, and work begun on placing reinforcement. Both of these photographs were taken at the Wieland Dairy Co. building, now under construction at 3626 Broadway, Chicago. The general contractor on that building is the Math Rauen Company and the architects are Teich & Sullivan, all of Chicago.

A much larger building on which similar forms were used is the Sheridan-Grace Apartments, a 17-story reinforced concrete building now approaching completion at the northwest corner of Sheridan Road and Grace Street, Chicago. No construction photographs are available, but in its essential details the formwork was similar to that on the Wieland Dairy Co. building. The general contractor on this building is the Avery Brundage Company, of Chicago, and the architect is B. Leo Steif, also of Chicago.

The Sheridan-Grace Apartments

One Contractor's Experience

An interview with Mr. C. T. Montague, superintendent of construction for the Avery Brundage Co., brought out some very interesting information.

These forms, said Mr. Montague, permit great speed in the construction of the reinforced concrete structural frame, for the rigidity of the forms allows the carpenter forces to work on a floor 24 hours after the concrete is placed; furthermore, the amount of labor required to erect these unit forms is much less than where ordinary methods are followed. The form boxes may be taken out in two days and the form joists in six or eight days, as a rule. Even though the structural concrete work on the Sheridan-Grace Apartments was all placed in February, March and April, 1927, and much cold weather was encountered, the average speed for the 17 stories was two stories a week. On this work Mr. Montague had enough form units built to take care of two and one-half floors at a time. All the forms were used over and over, and on completion of the structural work on this building they were still available for use on the next contract.

Low Form Cost

But even if the entire cost of this set of forms were charged to the Sheridan-Grace Apartments, the cost is still less than the cost of formwork of other types. On the Sheridan-Grace Apartments, Mr. Montague said, the cost of the formwork was 15 cents a square foot of actual contact surface. This includes the low figure of ¾ cent a square foot for erection of forms. On a building now under construction by the same contractor at Wabash and Twelfth Streets, with the same form-erection crew doing the work, the cost of the formwork of another type of floor construction is 24 cents a square foot of actual contact surface.

Other Economies

Speed of erection may also be compared on the two buildings just named. The structural frame on the building where standard forms were used, though built in winter, went up at the rate of two stories a week, while on the other building the rate is one story a week.

Aside from the saving on cost of formwork Mr. Montague estimates a saving of 480 cubic yards of concrete on the Sheridan-Grace Apartments because of the absence of the batter on beam sides, the elimination of rounded corners and the absence of waste often caused by the springing of forms. There is also an undetermined saving because of the greater speed and the reduced interference with other trades.

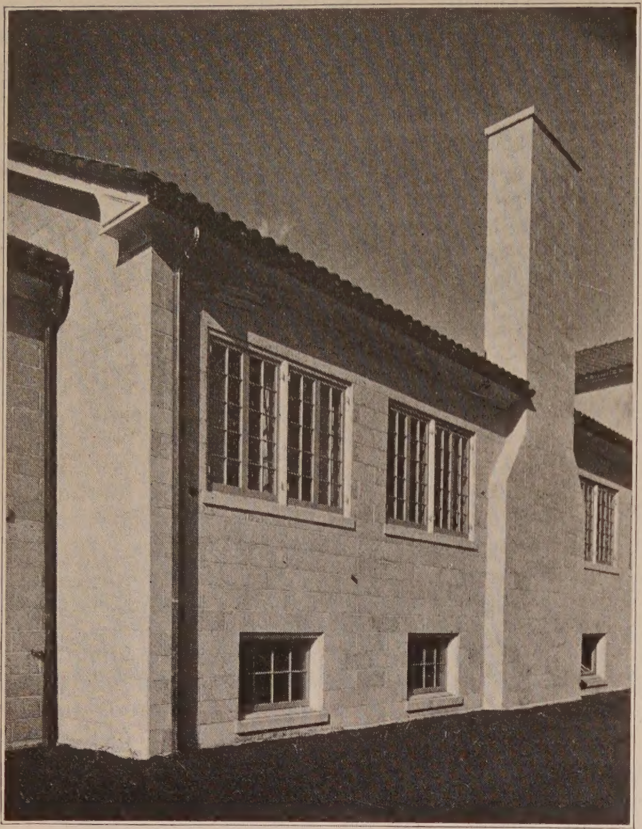
On the Sheridan-Grace Apartments project the form boxes were made up in advance by the carpenter forces, from layouts furnished by the S. J. Branson Company, structural engineers, Chicago, holders of the patents.

Road Builders Offer Prizes for Plans to Reduce Accidents

The rising figures of accidents on highways have impelled the American Road Builders Association, Washington, D. C., to offer $1,000 in prizes for the best ideas for reducing accidents.

The awards are offered for the best workable plans. An entry may be a complete comprehensive thesis covering the entire subject or nothing more than a description of a single idea that would contribute to highway safety. A reasonable amount of money should cover the operation of the plan.

The first prize in the contest is $500. There will be nine other prizes totaling $500. Winners will be announced in the press and by radio on January 11th, during the annual convention and road show of the association in Cleveland. The ideas submitted for the contest will be assembled into a report to be presented to the convention.



The new clubhouse of the Olympic Golf and Country Club is an outstanding example of the use of concrete masonry units

He Sold Concrete Masonry Walls — *Inside and Out!*

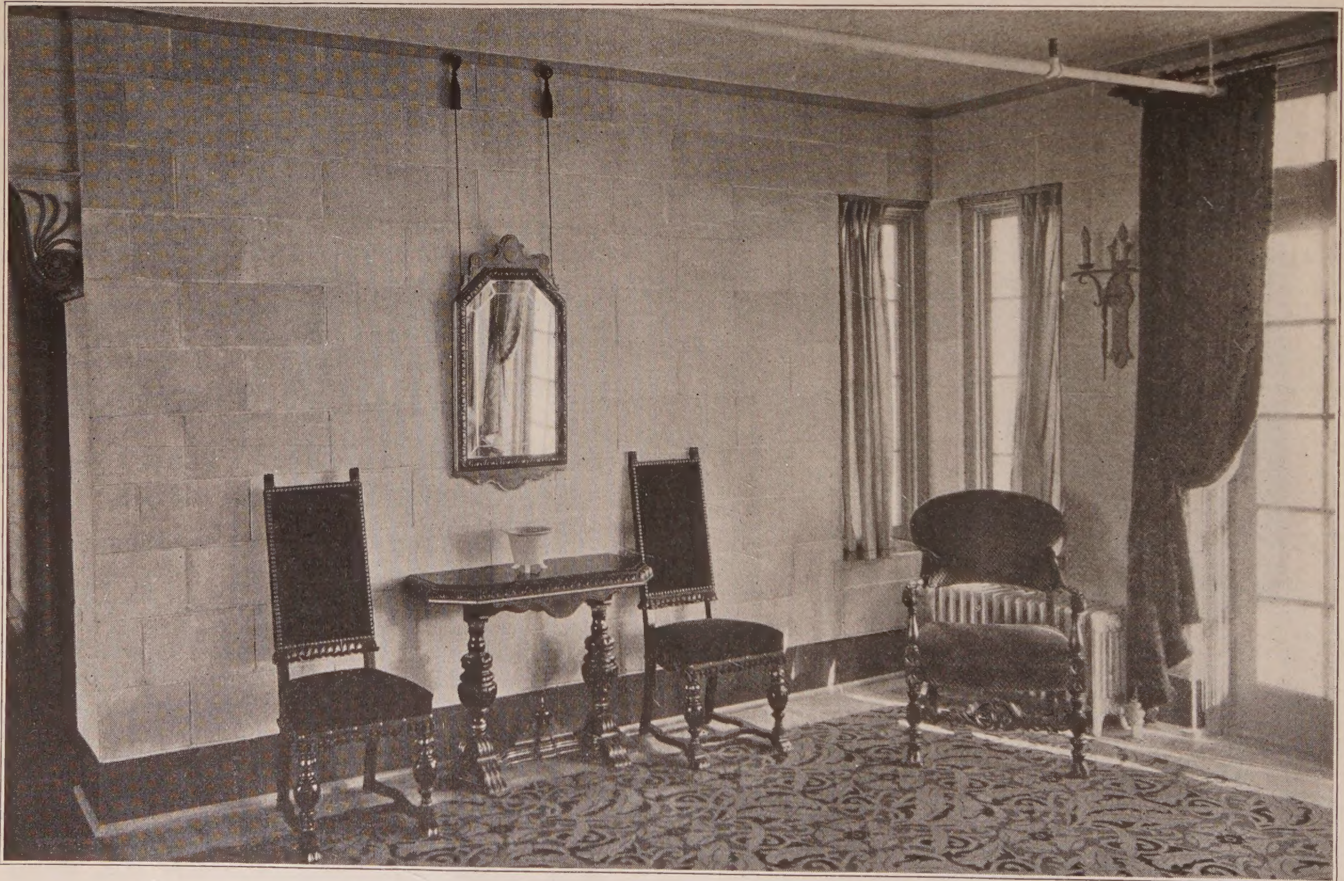
WHEN the new clubhouse of the Olympic Golf and Country Club, near Wheeling, Illinois, was built with concrete masonry units, two principles of greatest importance to the concrete products manufacturer were demonstrated.

First of all, without intelligent, aggressive merchandising on the part of C. L. Jones of the Hydraulic Art Stone Company, the building would have been constructed of lumber. In fact, the plans had all been prepared and the building was designed to be a frame structure. Confidence in his material and salesmanship swung the job to concrete.

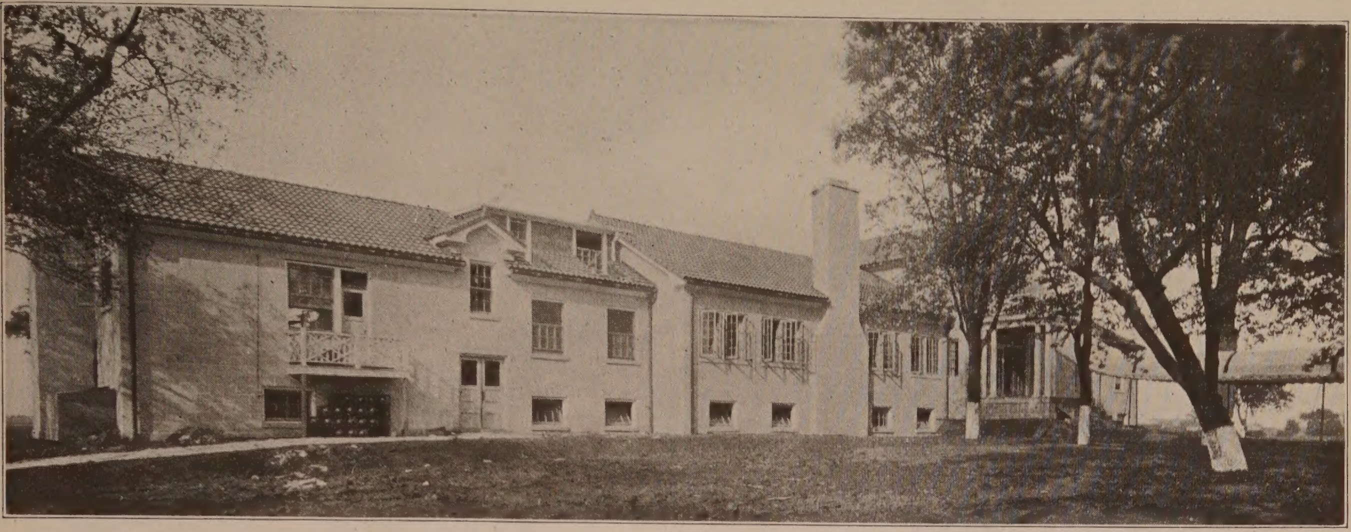
Secondly, the use of concrete units for both the inside and outside walls in a building where beauty is of primary importance, indicates the extent to which concrete masonry units can be used when they are properly made and intelligently sold. The building *is* beautiful, inside and out, and concrete masonry units have made it so.

All Concrete Walls

An accompanying illustration shows the type of wall



The lobby of the clubhouse. The walls are of concrete units resembling limestone. The baseboard is also reconstructed stone with a pitch black concrete facing. Here the concrete masonry unit has come into its own



The building was originally designed as a wooden colonial type structure. Real merchandising switched the construction almost at the last moment to concrete. C. L. Jones of the Hydraulic Art Stone Co. showed the builders how the use of concrete units would eliminate plastering and painting and would cut depreciation, insurance and upkeep costs

construction used. The units are "reconstructed stone," made by the Hydraulic Art Stone Company at their plant at Halfday, Illinois, on the machine made by the Hydraulic Stone Machinery Company of Little Falls, New Jersey.

The two-piece type of wall construction was used. Two units, one forming the inside wall and the other forming the outside wall, were laid up as shown in the illustration. The courses are 9 inches high and the standard length of the building unit is 24 inches. Special sizes ranged from 3 inches to 24 inches in length. Main walls are 12 inches thick up to the first floor level and 8 inches above. Partition walls are 7 inches thick and interlocked with the main walls as shown in an accompanying illustration.

The outside wall units were faced with a concrete mixture in which pink and black granite and a small amount of carborundum was used. These aggregates were mixed with a white waterproof cement and the result was an attractive surface resembling gray granite.

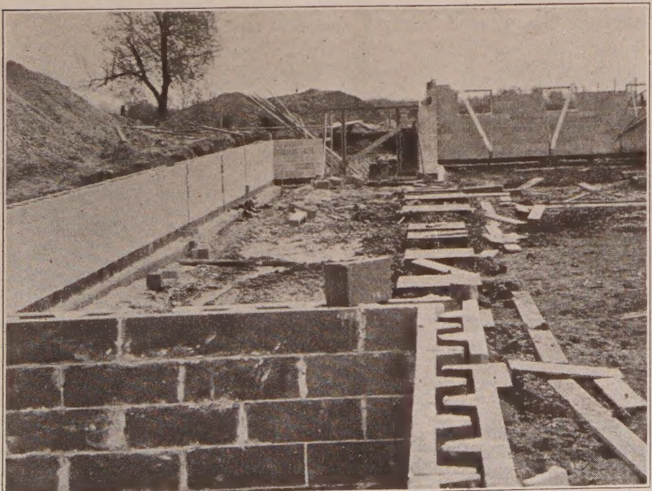
The inside wall facing resembles limestone. Aggregates for this facing consisted of 60 per cent white marble, 20 per cent silica sand and 20 per cent dark bank sand which brought the tone down to stone color. White, waterproof cement was used for the inside facing mixture also. The backing concrete was made with ordinary aggregates and standard gray portland cement. A baseboard course in which a jet black facing was used was placed as the bottom course on all inside walls.

There are two large chimneys made with the same type of units that were used for the outside walls. Window sills, water tables, baseboards, trim and all special units were made of concrete on the same machine that made the wall units.

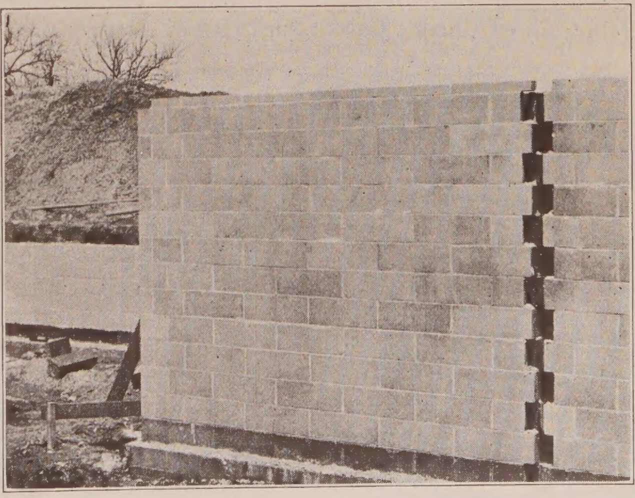
Advantages of Concrete Masonry Wall

One of the most important sales arguments used in switching the construction from frame to concrete was the ultimate economy of the concrete masonry wall. By using reconstructed stone all plastering and painting costs could be eliminated. Insurance rates would be lower, upkeep and depreciation would be reduced, so that over a period of years the concrete wall would actually be cheaper than frame.

As for appearances, Mr. Jones took the owners and architect to his plant and showed them some of the units already in place in the walls of the plant office. He



Illustrating the type of unit used and the method of laying up the wall. When the walls were laid up, no further work was necessary to finish them



All partition walls were interlocked with the main building walls. The illustration shows the method of loading the partition walls into the building walls

All the the wall units, chimney, watertables, trim, sills, and baseboards are of concrete. Even the roof is of concrete tile

demonstrated how almost any desired facing could be obtained and showed them the manufacturing methods used to assure them that the walls would be made of quality units.

The building is a clubhouse serving a membership of 400 playing members and 300 non-playing members. The entire cost of the building, including furnishings, was in the neighborhood of $100,000. It measures 166 feet in length and 46 feet in width.

In the basement are the men's locker rooms, showers, professionals' room, the 19th hole, boiler room and storage room. The first floor consists of the lobby, the main office, a dining room seating 175 people, a kitchen and a large glazed porch. Card rooms, ladies' lockers and showers, and living quarters for the employees are located on the second floor.

Over 24,000 concrete units were used in the construction of the building. Each of the five masons with his helper laid from 175 to 200 units per working day. The units used in the 8-inch wall weighed 40 pounds each and those used in the 12-inch wall weighed 50 pounds each. They showed a strength of 2200 pounds per square inch.

The Hydraulic Art Stone Co., who made the units, also had the general contract for the erection of the building. H. G. Gemmill is president of the company and C. L. Jones is secretary and treasurer. The owners of the building are Dr. Francis J. Buss and J. H. McFarland. Paul Frederick Olson of Chicago was the architect.

More than 24,000 concrete units were used in the building. Paul Frederick Olson of Chicago was the architect

The Future of Reinforced Concrete*

Periods in the Development of Reinforced Concrete—Early Methods of Designing and Placing Concrete—Some Faulty Methods Still Used—Rationalization of Design—Standardization—The Present and Its Problems—Improving Concreting Practice—Factors Affecting the Durability of Concrete — Effect of Mixing Water on Porosity—Volume Changes in Concrete—Inelastic Deformation—The Future and Its Possibilities

By F. R. McMILLAN
Director of Research, Portland Cement Association

Part I

The role of prophet is a difficult one. But often a backward glance, coupled with a searching analysis of present conditions, will point to possible future developments. At least it will show present tendencies and will suggest the need for certain definite activities that will mold the future favorably.

In this paper, Mr. McMillan frankly faces the problems of the reinforced concrete industry. Lately, reinforced concrete has been severely criticized. Mr. McMillan answers these criticisms in this paper. He discusses the question of durability of concrete and volume changes. He gives definite recommendations for overcoming these shortcomings.

The discussion is of vital interest to everyone in the reinforced concrete field. A careful reading will show how you can do your part to improve the future of your industry.

THE development of the reinforced concrete industry may be characterized loosely by five major periods or tendencies:

- Invention
- Pioneering
- Commercialization
- Rationalization of Design
- Standardization

None of the tendencies, which characterizes the different periods, is peculiar to a single period alone, but in a general way, the art has progressed through several stages in each of which one of these tendencies predominates.

Success of the Early Structures

During the periods of invention and early pioneering, the number of structures produced and the types represented were quite limited. It was, however, upon the successful performance of these structures, that the further growth of the art was to rest. Had these structures failed to carry the loads or had they developed any signs that the new method of construction was unsound, we would not be here today discussing the future of reinforced concrete.

Crude as were the methods of design and inexperienced as were the builders in handling the new material, the results were stable structures which inspired the confidence of the many followers in the art. Some of the very earliest structures of the pioneer builders are still in existence, giving evidence of the enduring quality of their work.

Commercialization—An Era of Rapid Growth

While the transition from the pioneering period to commercialized building in reinforced concrete was in no sense sudden, the tendency is well marked. The individual work of the pioneer builders provided the training ground for the men about whom were built the organizations which dominated the period of rapid expansion.

The period of intense commercialization is undoubtedly the most significant period in the development of reinforced concrete in this country. At the beginning of this era, the methods of design and processes of construction were those learned from the pioneers, but with the expanding of the early organizations, and the springing up of new ones, new ideas and methods were rapidly being introduced. Many of the innovations were well considered and contributed to the substantial growth of the industry. Unfortunately, however, this was not true of all the systems of construction or methods of computation that were introduced.

The stability of the early structures and the commercial success of the builders tempted men of mechanical skill, but often lacking in the fundamental knowledge of structural mechanics, to attempt new systems or combinations which experience and analysis have since proven inadequate or unsound.

The innovations of this period included special types of reinforcing bars, different schemes for column and web reinforcement, various systems of unit construction and many arrangements of beams, girders, and slabs and systems of reinforcement for girderless floors; yet, in the face of this endless procession of new and untried devices, the failures were comparatively few. This is the more remarkable when it is considered that the art of making concrete itself was passing through a critical period in which the proven method of placing by careful ramming of stiff mixes was being abandoned in favor of wet mixes which flushed easily into place through the network of reinforcement. While a change was made necessary by the requirements of the combination of concrete with steel, no information was available to provide a safe guide for the transition.

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*Presented at the semi-annual meeting of the Concrete Reinforcing Steel Institute, September 20th.

The Pantheon at Rome is one of the oldest existing structures in which reinforced concrete was used. It was built in 117-138 *A. D., and the dome, over* 140 *feet in diameter, was placed as a single concrete cast*

Failures Due to Carelessness and Ignorance

Most of the failures were found to be due to a combination of inadequate design, poor materials, and carelessness or ignorance in construction. They almost invariably occurred while construction work was still in progress. The record discloses practically no cases where structures have failed after once being placed in service. The great majority of the structures built during this period are still in use or were until displaced by more modern ones. This of itself is a significant endorsement of the integrity of reinforced concrete construction.

Unfortunately, the undesirable practices of this period of development have all been too slowly eradicated. Present standards still occasionally show the influence of individuals trained under the old system. The ability of the material to survive the most flagrant abuses is in part responsible for some present-day construction practices and rule of thumb designs that should long since have been abolished. But what other industry has not been similarly hampered? It needs but a moment's consideration of the rapid trend, so evident in all lines, toward the advancement of industry through scientific research to realize that the "trial and error" method of development was not peculiar to reinforced concrete.

Rationalization of Design

The problems presented by the structural combination of concrete and steel early attracted the attention of scientific men. By the time the development had reached the stage of marked commercial importance, the work of these investigators had begun to bear fruit. Technical articles, research bulletins, and textbooks began to appear. As these grew in number and importance, more trained men were attracted to the growing industry with the result that methods of design based on the accepted principles of structural mechanics were developed.

While this development of rational methods of design marked an important advance in the industry, it opened the way for the growth of an unfortunate tendency in the commercial field. The confidence, which was established by the achievement of rational methods of design, led many to think that little remained to be learned, and the feeling developed that design of structures required nothing but the application of tables and diagrams, or the solution of a problem in algebra. With this impression prevailing, designers of concrete were made over night and a period of competition arose in which all too frequently the sole test of merit was that of cost. While only a part of the designing work done during this period was of this character, the condition was an unhealthy one from which the recovery was none too rapid.

It is important to record also that while the results of research in the problems raised by the combination of steel and concrete was finding application in the rationalization of designing methods, little was being done to improve the material itself, either through suitable mixtures or better methods of handling. With an accepted rational method of design and with many examples of successful structures in service, there was little incentive on the part of builders to inquire deeply into the practice of mixing and handling concrete.

The lack of response to the advancing knowledge from research was considerably more evident in the matter of materials than in the field of design and much of the concrete of this period was of indifferent or poor quality. While the performance under load of the structures built under these conditions has been generally good, the poor quality of the concrete combined with careless placing of the reinforcement often led to the corrosion of the steel in exposed locations, creating a condition that has done much to excite unfavorable criticism of reinforced concrete.

A modern reinforced concrete building, the Santa Fe Railway office building at Dallas, Texas. It is 21 *stories high and was built in* 1924

Standardization

Following closely upon the period just described, and, as before, difficult to differentiate sharply from it, there is that period of standardization which closes the gap between the past and the present. This standardization, which is still in progress, was brought about by the recognition of some of the deficiencies that have just been pointed out. It was realized that practice has not always kept pace with the knowledge gained from research. This condition arose largely through the custom of awarding work to the lowest bidder, regardless of previous experience or proven ability and from the prevailing idea that little training was required for the ordinary operations of making concrete.

A number of influences have been at work to further the ends of standardization which have largely found expression through the committee activities of the technical societies. The work of the Joint Committee on Specifications for Concrete and Reinforced Concrete, and its predecessor, the activities of the Department of Commerce through its Division of Simplified Practice and the Building Code Committee, the Committee on Building Regulations for Reinforced Concrete of the American Concrete Institute, and more recently, the work of the Committee on Engineering Practice of the Concrete Reinforcing Steel Institute, are typical of the activities that have furthered the standardization of practice. While it is not likely that any of these efforts have accomplished all that their sponsors may have hoped for, there can be no doubt of the general improvements that have resulted from the combined influence of these several important contributions.

The oldest reinforced concrete bridge in the United States. It is located in Golden Gate Park, San Francisco, Calif.

The Present and Its Problems

In this brief review of the growth of the reinforced concrete industry, emphasis has been placed on those practices and tendencies which largely account for any unsatisfactory results that have been obtained, for it is through an understanding of the failures as well as the successes that the problems of the present and the possibilities of the future may be visualized.

As regards the successes of the past, there can be no doubt. From the earliest beginnings, the use of reinforced concrete in many types of structures has been eminently satisfactory. While its period of phenomenal growth in this country is coincident with the general expansion of industry, this alone cannot account for its rapid growth in comparison with other structural materials. Nothing but generally successful performance and economic feasibility could account for the rate of increase that has characterized its history. Sweeping aside for the moment all details as to the problems of the present or future, it must be recognized that reinforced concrete has demonstrated its adaptability and permanent value, and nothing save an unbalance of the economic factors that have aided in its growth can stand in the way of its future progress.

The Colorado Street bridge in Pasadena, Calif., is an example of modern reinforced concrete bridge construction

The problems which the industries now face will be sketched briefly with more detailed comment in the case of some of the specific problems of immediate concern.

The rapid rise of reinforced concrete has been in no small way due to the ever-expanding program of careful research throughout its history. In the case of no other building material can there be found such a wealth of research data as in the case of reinforced concrete. This program must be continued as new problems are continually arising which can be solved in no other way. More agencies should be engaged in this program and all branches of the industry should co-operate.

Necessity for Education

Another broad task before the industry is a more comprehensive campaign of education that will bring to the attention of every individual in the various branches, the detailed knowledge necessary for the proper performance of his particular task. Such a campaign should include also the education of persons not directly within the industry, but who should be enlightened on such factors as the following:

(1) Practice of letting contracts to the lowest bidder, regardless of experience or proved ability;

(2) The necessity for competent inspection of the construction operations;

(3) Need for modern building codes, which recognizes the advances which have been made in concrete construction.

Improvement in Concreting Practice

Of major importance also is the problem of improving the practice of proportioning and placing concrete. In this particular, practice generally has lagged far behind the results of research. While the final chapter in the discussion of concrete proportions has not been written, enough has been definitely established to warrant a general revision of practices long in vogue. Those who are closely following the progress in the art of making concrete know that considerable advance has been made in recent years and that the success which has attended these improvements warrants the assertion that a general adoption of the methods not only will greatly improve the quality and workmanship, but will prove economical and profitable as well.

More Attention to Durability

Economy and strength have too long been regarded as the prime essentials of concrete construction. The importance of durability must now be recognized. Attention is already being focused on this problem by many examples of structures where insufficient protection of the reinforcement has led to corrosion of the bars and spalling of the concrete. In a number of cases this corrosion and spalling has progressed to the point where extensive repairs have been or should be made. In any case the result is an unsightly appearance that attracts criticism and often a feeling of distrust.

A careful study of many structures in this condition has disclosed a surprisingly regular relationship between the extent to which corrosion and spalling has progressed and the severity of exposure, the depth of concrete protecting the steel and the quality of the concrete. In a single structure can be found all stages of progress which suggest the depth of protection needed for the kinds of concrete found in the particular structure. It is not uncommon to find that ¼ to ⅜ in. of good concrete has protected the steel perfectly in outside members above ground, where exposed to the usual climatic conditions of northern United States. Thicknesses less than this and even greater thickness when the concrete has been flushed into place with gross excess of water, generally show a corrosion of the steel, the progress of which can be traced with the increasing severity and time of exposure.

The remedy obviously is better protection of the reinforcement by good concrete of proper depth. This requires more care in the placing of the steel and in holding it in the desired position. Particular attention must be given to lateral reinforcement in columns, and stirrups in beams and girders as these usually form the first point of attack. The depth of protection will depend upon the type of exposure. A minimum of ¾ in. would be fair requirement, this to be increased as the severity of the exposure requires. In structures subjected to the direct action of water and low temperatures, from 2 to 4 in., depending upon the kind of concrete, would not be an excessive requirement.

Resistance of Concrete to Corrosion

There is another phase of the problem of durable structures that is receiving considerable attention and that must be accepted by the industry as one of its problems of first importance. This is the question of the resistance of concrete itself to the action of the elements. Perhaps the reinforcing steel interests may not regard this as a problem of their branch of the industry, but nevertheless, a vast amount of reinforced concrete business in the future will depend upon the extent to which assurance can be had that the structures will endure. It may not be amiss to digress from the theme of durability long enough to point out that every branch of the industry; cement manufacturers, aggregate producers, equipment manufacturers, reinforcing steel interests, architects, engineers, and contractors, must accept responsibility for whatever they contribute or fail to contribute that affects or could affect the future of the industry. Only when each group recognizes its obligations and co-operates in the solution of the problems that arise, can the great future which is possible for reinforced concrete be realized.

To return to the question of durability. Much thought is now being given to the production of concrete that will resist the elements. All who have studied the problem agree that when good materials have been used and properly mixed, the chief factor in determining the resistance of concrete to weathering is its porosity. The compounds formed during the hardening of cement are not wholly insoluble and it is vital to the permanence of a structure that the porosity of the concrete be kept to a point where no important quantity of water can find its way through the mass and thus carry away essential ingredients. Some observers have questioned whether it is possible to produce concrete that will be sufficiently impervious to insure indefinite resistance under the conditions prevailing in the usual hydraulic structures.

The conclusion has been drawn from a very extensive study of hydraulic structures under severe exposure that with good materials such as are available in many localities in the United States, it is possible to make structures that are durable to the extent which may be reasonably expected from any of the works of man.

Two significant facts will be cited in support of this conclusion, both of which have seemed to escape the comment of other observers. First, while it has been recognized that the cement is the vulnerable point in the concrete, no explanation has been offered heretofore of the fact that the richer mixes give the greatest resistance to weathering. Second, a close study of almost any badly disintegrated structure will show considerable areas that are wholly unaffected. It seems to the speaker that these two facts not only show that it is possible to produce concrete that has sufficient watertightness to resist the action of the elements, but point to the source of this resistance. A brief explanation should suffice.

Effect of Mixing Water on Porosity

Concrete, which is honeycombed and full of air voids when placed, will not be resistant under any condition. Concrete, which is placed in a plastic condition and properly puddled so that the aggregate particles are thoroughly incorporated in the cement-water paste, will have no air voids. Any water which enters the mass after it has hardened must do so through space once occupied by the mixing water which was not utilized in the chemical changes incident to hardening. Thus, the porosity of the concrete is determined by the quantity of this uncombined water. This explains why the richer mixes give less porosity and, therefore, greater resistance, for they require less mixing water, and for the same degree of curing, therefore, give a paste which has less uncombined water. Longer curing, which permits more complete chemical reaction in hardening, likewise reduces the porosity by reducing the amount of this uncombined water. All the facts of experience and laboratory studies support this explanation of the cause of porosity.

Anyone at all familiar with the usual concrete operations can visualize conditions of construction that will account for considerable variation between different portions of a structure, in quantities of materials, water content, and curing. It is these that bring about the difference in porosity that accounts for the varying resistance offered by the different portions of a single structure. It is generally possible from a careful study of a structure where some disintegration has taken place to trace these various influences. When this is done, the conclusion is inescapable that by applying the knowledge which we now have, it is possible to produce concrete that is practically permanent; thus, the problem of durable concrete that is presented to the industry, important as it is, does not seem difficult to comprehend, nor incapable of a practically complete solution.

(To be continued in the November issue of "Concrete")

EDITORIALS

The Fire Safe Age

THE present period is often referred to as the Concrete Age. Perhaps this period, in which the uses of concrete have increased and multiplied, deserves that name. But if the Concrete Age had truly come, it would also be the Fire Safe Age.

With a $60,000,000 loss annually in dwelling house fires, with schools, hotels and hospitals burning at the rate of from one to five each day, it is evident that the Fire Safe Age, and therefore the Concrete Age, has not yet arrived.

There are still thousands of schools, hotels, and hospitals that are being built with combustible materials. Only a small percentage of new dwelling houses are built of fire-resistant materials.

Universally fire safe construction is still only a dream. But gradually we are learning that schools, hospitals, hotels, and similar structures ***must*** be made fire safe. A few of us are demanding fire safe homes. We have taken a step toward the coming of the Fire Safe Age.

Fire safe construction can become a reality through education and legislation. When builders realize the advantages of building against fire, more fire safe structures will be erected. When our public officials have learned these same lessons, building codes that favor the use of fire-resistant materials can be adopted.

Concretors have an especial interest in these activities. Fire Prevention Week, October 9th to 15th, is an opportune time to help hasten the arrival of the Fire Safe Age and thereby extend their industry.

Winter Work Is Good Business

EACH year an increasing number of contractors are planning to lengthen their construction season to the full twelve months of the year. They refuse to let the old-fashioned winter bogey scare them out of profitable contracts.

Building statistics for the past few years testify to the practicability of this new, common-sense attitude of the construction industry. Builders can see no logical reason why an industry of such magnitude should suddenly stop in its tracks and lie idle for four or five months.

Each year a greater number of buildings are financed and constructed during the winter months. Payrolls and purchases of building materials are larger during each winter season than they were the previous year. Progressive builders are cashing in on this movement.

A multitude of reinforced concrete structures are standing, eloquent testimonials to the practicability of carrying on reinforced concrete construction in cold weather. The builders who erected them have become ardent advocates of winter work. They have found that, while there are some premiums on winter work, there are also some very tangible advantages.

They have found that the direct additional cost of winter construction is only a very small percentage of the total cost of the building and that such direct winter costs are more than offset by the savings that winter construction make possible.

Among the indirect savings which will counterbalance the slightly higher winter construction costs are: reduced labor turnover; keeping the organization intact; spreading overhead over a longer period; seasonal discounts on materials; seasonal transportation rates on materials; saving of interest and taxes on idle equipment and property as well as earlier returns on investments.

The wise builder is preparing now to continue work right through the winter season. Some special equipment for heating materials, for housing and heating the structure are necessary. Precautions to prevent the freezing of concrete are a necessary part of winter work. But the investment in special equipment and the care required to insure quality concrete in winter are not excessive.

Continuing the construction season through the winter benefits many besides the contractor. The earning capacity of the men employed on the work, of those supplying the building materials, and of many others will be increased by continued activity in the building industry. A stimulation of business in general will result.

Winter construction of reinforced concrete structures is practical and advisable. The winter ahead should show the biggest volume of construction ever undertaken during the winter months. You should have your share of that work.

An Editor Passes

ELSEWHERE in this issue is reported the death of Frank C. Wight, editor of Engineering News-Record. We cannot pass over this event without a word of appreciation of Mr. Wight's unfailing emphasis of the highest and best of business editorial standards. Under his editing Engineering News-Record has maintained a record of consistent and impartial service to its field of which any paper serving the construction industry might well be proud. We regret his death and shall miss his helpful presence.

Here and There

Some Random Notes on Visits with Concretors in the Field

THE leaves are turning red and gold, the katydids are chirping in the fields and fall is coming. Winter is not far behind. But what of it? Nowadays the products manufacturer and the concrete contractor do not hibernate like some of the poor, dumb beasts that crawl into their holes to wait for spring.

There is much to do in the cool days that are coming. It is not necessary to stop sales efforts and promotional or even construction work. Many a big job is put over in the fall and winter months and many an important building is erected in cold weather.

Then, too, the winter is a dandy time to build up that stock pile, to repair that machine that was causing trouble, to fix up the plant and to put in those labor-saving changes that you thought of when you were too busy to do it.

The winter months can be made to be more productive than they have ever been.

Don't hibernate!

◆

CAN you increase your repeat business? Many products manufacturers do not go to enough trouble to hold their old customers. They just take it for granted that they will come back. Maybe they will and maybe they won't. Don't forget that your competitor is cultivating them.

One products manufacturer got to thinking about that question and he decided to check up to see how many of his orders were from old customers and how many were from new customers. He was surprised to find that his repeat business was quite small. So he decided to make an effort to hold his old customers. He found that it paid.

◆

THERE seems to be increasing interest in the preservation of historic structures and concrete plays an important part in this worthy work. Some time ago, you will remember, the historic bridge at Concord, Mass., where "was fired the shot heard 'round the world," was rebuilt in concrete, faithfully reproducing the old wooden bridge that was fast falling to pieces.

Now another historic structure—the block house that was Fort Buchanan, near Versailles, Ind.—is being reproduced in concrete so that it will be preserved against the destructive effect of time.

◆

IN Lucas, Kansas, is an old man who has made concrete the hobby of his declining years. His idea of self-expression in concrete takes a religious turn. In his garden he has modeled in concrete his conception of what the Garden of Eden was like. There is a concrete Adam and Eve, a concrete devil and everything described in the Bible as being present in the Garden of Eden. Mr. S. P. Dinsmoor, who is the creator of the concrete Garden of Eden, is 84 years old. He lives in a concrete log cabin.

THE most ancient structure of all, the monoliths at Stonehenge in England, are being reconstructed in concrete. A Mr. Wm. Burrough Hill has built actual size replicas of the ancient monoliths in his garden at Southampton.

◆

DON'T forget Fire Prevention Week, October 9th to 15th. While interest is running high in fire prevention is an opportune time to talk about the fire-resisting qualities of concrete products. Put an ad in your local paper, tying it up with Fire Prevention Week. It is worth while cashing in on national movements of this sort.

◆

TALKING about fire prevention, the National Board of Fire Underwriters has gone on record as endorsing the concrete tile roof and put it in Class A as a fire-resisting roof. The annual dwelling house fire loss is around $65,000,000 and records show that a third of the fires causing this tremendous loss start on roofs. Everybody wants to protect his home from fire and a good place to start is at the most vulnerable point—the roof.

◆

AND while we are on the subject of fires in homes, let us remember that the greatest number of fires begin in the cellar or basement. Some authorities say that 70 per cent of the fires start there. A concrete floor would practically eliminate this danger because it would confine the fire to the basement.

And when it is known that the cost of using concrete for the first floor increases the cost of the building only one per cent, there seems to be no good reason why most dwelling houses should be built without them. A great many artistic finishes are possible with a concrete floor surface. Some of the finest club buildings have concrete floors in their most important rooms. It's worth while considering.

◆

"THE trouble with too darn many concrete products manufacturers is that they haven't enough confidence in the material they are manufacturing and selling," said a successful products manufacturer recently when we were discussing the future of the products industry.

"How can they expect anyone to be enthusiastic about concrete products if they themselves are not enthusiastic. Confidence begets confidence. Even if you don't express your doubts and fears, the prospect senses them and loses interest."

Isn't that true? You know products manufacturers who have definite ideas of the limitations of the use of concrete products. They don't dare to go out and sell them for above ground use and are content to get the basement and foundation jobs. How can they sell concrete units for above ground use unless they themselves are convinced that they are suitable for such use.

Get sold on your own product—then see how much easier it is to sell it.

Products Advertisements That Are Read

Some Helpful Suggestions for Advertising Concrete Products

By A. A. SHIELDS

"GOOD advertising copy poorly set up is like an automobile with flat tires—neither will get very far."

This opinion by Axel Edw. Sahlin, in Inland Printer, particularly applies to the advertising of manufacturers of concrete products and of concrete contractors.

There are so many other advertisers of building materials on the newspaper road that the reader will not get aboard the concrete vehicle if it seems to have flat tires; people want to get somewhere today.

Incidentally, there is a whole lot of copy that is used by concrete products firms that wouldn't sell much even if it was set up as it should be.

Now is a good time for the concrete products manufacturer to consider the application of the newspaper reporter's principle of concrete product advertising. Maybe you have heard that a reporter is supposed to answer in each story or article that he writes the questions: "Who? what? when? where? why? and how?"

"BUILD WITH PERMANENCE"

Concrete Block

Made by

Irwin Cocrete Block and Brick Supply Co.

Phones 719—Res. 327-W. Irwin, Pa.

Concrete Block 6x8x16 **Concrete Block 8x10x16**
Concrete Block 8x8x16 **Concrete Block 8x12x16**
Chimney Block **Cespool Block**
Flower Vases, 4 different sizes for Lawn and Porch.
Cistern Block, make a cistern permanent.
Window Sills and all kinds of **Coping.**
Distinctive and artistic **Porch Columns.**
Pool Tile in French design, red or green, cost no more than slate.
Clothes Line Posts, cost no more than wooden posts.
Cemetery Lot Corner Stone, marked with numbers on it.

FOR THE FARMER AND HOME OWNER

Concrete Posts, for gates and corner posts, all reinforced, become stronger with age, not affected by the elements, insects or fungi; are not damaged by fire. Weeds along the fence line can be burned off without damaging them, accidental fires do not destroy them. Relieves the farmer of the tiresome and expensive job of replacing portions of the fence line annually; make farms more attractive and increase the sales value.

Every single item that leaves our plant must be of the high guaranteed type. We are determined to prove to the people that the Irwin Concrete Block & Brick Supply Co. is truly the home of fine Home Building units.

Quite a bit of specific information may be conveyed in a readable way

Look Before You Leap

Investigate First Then Build

Have you noticed that Straub Cinder Blocks have been used in the construction of the largest buildings in this vicinity during the past several years?

Have you stopped to consider that all these buildings were planned by reputable architects and engineers?

Do you realize that it is just as important to build a fire-safe home or garage?

Don't think of safety when you smell smoke, and the pretty red fire engines are making a midnight call.

Investigate now—before you build. You'll be surprised to learn that you can build with Straub Cinder Blocks at about the cost of flimsy, fire-feeding material.

Full particulars and estimate free.

Build Better For Less

Pottsville Building Block Company

POTTSVILLE, PA.

Effective use of a simple line rule border

You'd be surprised at the number of so-called concrete advertisements that give absolutely no information.

"Without attempting to suggest that advertisers attempt to adopt the reporter's style," says Hugh E. Agnew, in Printers' Ink Monthly, "would not many of them profit by the idea of giving such specific information at a glance?"

Make Advertisements Easy to Read

One common fault of concrete product advertisements is that they are hard to read.

The printers who set many of these advertisements do not know their formulas and the mixture of type that results is something awful. The eyes of the readers—if they would read it—actually travel a bumpy road, as your oculist would tell you.

"The reader should get the advertiser's message at a glance," said Mr. Sahlin, who warned against "flat tire" advertising, "especially in these busy days when the auto and radio play such big roles and the public has not much time to read. . . .

"Invite the public by easily read typography. 'Type was made to read' and legible type must be selected."

You need not be concerned so much with fancy borders. Ask for simple line rule borders, which the printer can give you without further delay and expense.

"The line rule border is, of necessity, dignified, simple and unobtrusive," said a commercial art manager, in Printers' Ink. "It adds to rather than detracts from, other elements of display. It neither forces itself upon the eye nor consumes much space."

The concrete products manufacturer should take steps to see that the other advertisers on the page keep their distance. The use of white space is one of the important phases of advertising, as W. Livingston Larned points out in his book "Illustration Advertising":

Concrete

For Every Purpose

Ornamental cement work, garage floors, drive ways, curbs, walks, steps, posts and railing.

No Job too large
or to small

Wm. Orr

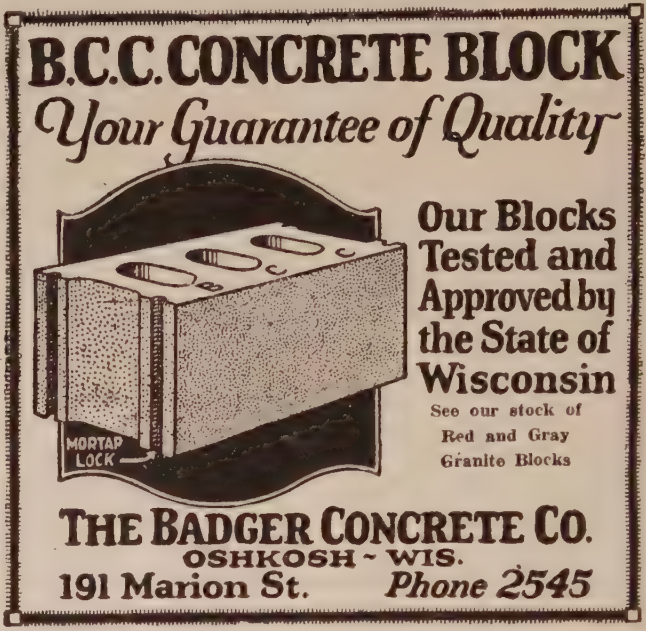
Phone 5028 ***Contractor & Builder***

A good example of plenty of white space

"The advertising display relieved and safeguarded by safety zones of white, most surely proves itself when in the midst of competition. Nothing can seriously detract from it because it has erected a barrier across which no confusion may leap. It is segregated by its frame of paper. It bids competitive display stand at a distance."

Illustrations

Few concrete products manufacturers use the right kind of illustrations in newspaper advertising. Many use the half-tone cuts which have been supplied them for printing their stationery on a better quality of paper. These illustrations—generally of burial vaults and bird baths or lawn furniture—come out in the local papers as almost solid black smudges. That is because the faces of the cuts have fine screens on them and the lines in these screens become filled with news ink and faster presses of the paper.



B.C.C. CONCRETE BLOCK

Your Guarantee of Quality

Our Blocks Tested and Approved by the State of Wisconsin

See our stock of Red and Gray Granite Blocks

THE BADGER CONCRETE CO.
OSHKOSH ~ WIS.
191 Marion St. ***Phone 2545***

An illustration of the superiority of a line cut

You'd just as well get black paint and smudge up the vaults and the furniture in your salesroom.

Concrete blocks are pictured much more satisfactorily by means of line cuts made from pen and ink drawings.

Concrete advertising is in mixed company and needs attention if it is to "stand out."

Construction Council Convention to Be Held in St. Louis

The sixth annual convention of the American Construction Council will be held in St. Louis, Missouri, at the Hotel Statler, on December 1st to 3rd, inclusive.

Details of the program have not yet been announced.

Those planning to attend are advised to make reservations direct with the hotel.

Slag Subject of Paper

Slag as a road construction material has been comprehensively covered in a paper published by the Missouri School of Mines, Rolla, Missouri, and prepared by Clarence E. Bardsley, Sc. D., Associate Professor of Civil Engineering. The uses to which slag has been put in structures from the earliest Roman period, and its manufacture are included in the resume.

A concise description of the manufacture of slag is taken up from the processes at the blast furnace until its use as a construction material. Tests from blast furnace slag, conclusions arrived at, and extensive bibliography on blast furnace slag follow.

Paint Over Cinder Block

A cinder block residence which has been finished with a coat of Zemcolite, a cement paint. It resulted in an attractive and well-wearing exterior.

Acoustic Concrete Wall Covering Developed

New Invention Gives Concrete Walls Unusual Acoustic Properties

By UTHAI VINCENT WILCOX

IT is claimed that for the first time in the history of architecture a hall with very bad acoustics has been scientifically transformed into one of excellent acoustic quality. This result has been achieved by covering portions of the inner walls, consisting in the present instance of hard glazed bricks, with Berliner's acoustic cement cells, applied in large oblong sections. As finished, the room appears to consist mostly of large smooth concrete panels which, however, are vibratory like piano soundboards and highly responsive to a tuning fork, and therefore to every kind of sound that strikes against them.

A school assembly room of the James F. Oyster School in Washington, D. C., was used by Mr. Berliner in a practical demonstration of his new device. Government officials witnessed the results. The room measures 84 by 44 feet including the stage and seats about 600 people. Previously this room was considered very bad and speakers found it almost impossible to make themselves understood. A jumble of noises was the result of any attempt.

The change brought about by Mr. Berliner was unusual. Two persons standing at opposite corners of the hall, about 80 feet apart, may now converse with each other in an ordinary speaking voice; every word is now easily understood and no impurity in the acoustics can be noticed.

Recently Lt. B. H. Rigg of the U. S. Coast Survey lectured to the children of the Oyster School in the Assembly Hall, on the MacMillan Arctic Expedition. The lecturer spoke without effort in a simple colloquial tone. Every word could be easily understood in any part of the hall, although Mr. Berliner's work was not entirely finished at the time.

Mr. Berliner handling the basic cell material that is used in the concrete to make the acoustic walls

Insures Good Results

The importance of this demonstration which represents an entirely new treatment of hall acoustics invented by

The tuning fork when brought lightly in contact with the block is easily heard in all parts of the hall

How the cells are fitted into the concrete base

Mr. Berliner may be widely used. Hitherto architects merely hoped that a new church, theater or hall would, when finished, prove to have good acoustics, but they could not guarantee that such would be the case. Long scientific and apparently logical dissertations dealing with hall acoustics have in the past been written by those teaching acoustics in universities and technical institutes. The best, however, that has been achieved with halls having bad acoustics has been by covering the walls with some sound absorbing material like felt or padded cloth. This would weaken the reverberation or other interfering sounds but would at the same time reduce the loudness of the original speaking or playing of instruments. Besides, such coverings absorb dust and germs and cannot be washed as walls in public buildings should be at intervals.

Cost Is Low

Mr. Berliner says that "New churches, theaters or halls can now be treated with acoustic cement cells at little more than the cost of ordinary walls and there appears to be no reason why in future there should exist any public places with unsatisfactory acoustics." He also notes that acoustic cement walls may be grained, painted and even ornamented without affecting their resonance. The cost of such wall coverings is estimated at about $1.50 per square foot. In order to insure satisfactory results, at least one-fourth of the wall area must be covered with the cement cells.

Concrete Reinforcing Steel Institute Meets

A whole-hearted desire to be of definite service to the reinforced concrete industry featured every paper and every discussion that was presented at the semi-annual meeting of the Concrete Reinforcing Steel Institute held September 19th to 21st at the Aviation Country Club, near Detroit.

A gratifying number of representatives of member companies met at the comfortable club house in the hills and lake country of Oakland County, Mich. Here they visited, played golf and discussed their problems. How they could accomplish the most good for the industry was the keynote of the entire meeting.

The address of the Institute's president, George E. Routh, Jr., opened the general session of the Institute. Mr. Routh reviewed the past work of the organization in formulating and putting into effect a uniform bar sales contract, promotion of a uniform city building code, simplification of sizes of reinforcing bars, and exchange of credit information.

One of the outstanding accomplishments of the past half year has been the preparation of a handbook on reinforced concrete. This is almost ready for distribution and will be reviewed in detail in next month's pages. The handbook contains a code of standard practice, specifications for placing steel, specifications for reinforced concrete, standard steel and cement specifications and design data.

Committees reported on publicity; progress in the adoption of a standard grade of billet reinforcing steel and progress in developing a building code that will serve as a single standard for the Reinforcing Steel Institute, the American Concrete Institute, the Portland Cement Association and the Rail Steel Bar Association.

Work has been undertaken to bring about a standardization of removable metal forms. There has been an increasing tendency on the part of architects and engineers to use special widths of forms which, in many cases, vary only slightly from the standard widths carried in stock. This practice results in increased cost. The Institute hopes to correct this situation by working in co-operation with government bureaus to bring about standardization.

Two formal addresses—one on "Selling—Markets—Profits," by E. St. Elmo Lewis, sales and merchandising counsellor; the other on "The Future of Reinforced Concrete," by F. R. McMillan, Director of Research for the Portland Cement Association—were presented. Mr. McMillan's paper is presented on other pages of this issue.

The meeting closed with a banquet and a golf tournament. Every afternoon was devoted to golf and visiting, the sessions of the Institute being held mornings and evenings.

Frank C. Wight Dies

Frank C. Wight, editor of *Engineering News-Record*, died of an infected throat on September 18th at his home in Summit, New Jersey.

The death of Mr. Wight deprives the concrete industry of one of the men who has contributed most generously to its progress. His studies of the effect of sea water on concrete, his writings on reinforced concrete design, and his work on the committees of the American Concrete Institute are particularly notable.

Mr. Wight graduated from Cornell in 1904 with the degree of civil engineer. After two years of work in the field he joined the editorial staff of *Engineering News*, and has ever since been engaged in editorial work on that publication and its successor, *Engineering News-Record*. Since January 1, 1924, he has been editor.

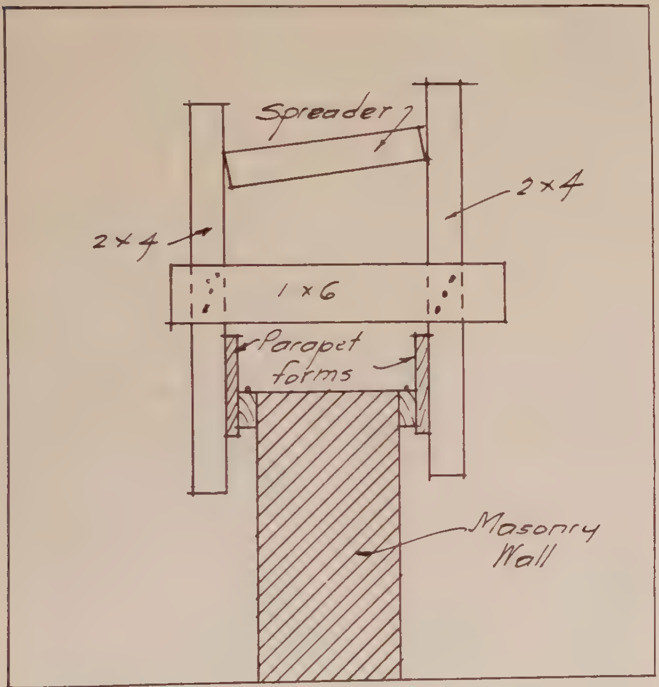
As a business paper editor, Mr. Wight has been conspicuously active in the development of the dignity and importance of his profession. At the time of his death he was president of the National Conference of Business Paper Editors, and he was a former chairman of the New York Editorial Conference. His death will be deeply felt by his fellow workers in the field of business journalism.

Practical Kinks from the Job

How to Brace the Forms for Concrete Sills

A QUESTION frequently raised is how to brace the forms for a concrete sill or coping to be cast on top of an existing masonry wall where standards or uprights to hold the sides of the forms cannot be bolted through the wall.

The sketch shows a simple method used by many contractors who have to do this work frequently. The parapet coping or sill form is built up as shown, the two separated parts of the form being held in place by nailing to temporary blocking laid across the top of the wall. The temporary blocking has been omitted from the drawing to simplify it. The nails into the blocking, like most nails in concrete form work, are not driven home, but on the contrary are left with their heads projecting so that they may be withdrawn easily before concreting commences.



After the form has been finished, it is clamped by means of a series of "H" yokes, which consist usually of 2x4's for the uprights connected with a piece of roofer or shiplap which can usually be nailed fast to the uprights as there will be enough play to the joint to act as a hinge. The space between the uprights should be the same as the out-to-out dimensions of the sill or coping forms, with just enough clearance so that the yokes can be slipped down over the forms. The upper ends of the uprights are then wedged apart, causing the lower legs to bind the forms tightly and hold them firmly against the masonry.

This method can be applied anywhere and as the clamps or yokes can be made out of almost any scrap material available, it is particularly advantageous where the amount of such formwork is too small to warrant the purchase of special metal form clamps, or where they are not available or cannot be obtained in time.

Placing Floor Topping

A GREAT many construction superintendents prefer to place floor topping some time after the structural slab has been cast. The advantages claimed for this procedure are many. The topping can be placed and kept much drier than where it is placed on top of the freshly concreted structural slab from which it ordinarily tends to absorb excess moisture. Because of the smaller quantities involved and because the placing of finish can be started at 8 o'clock, overtime for masons is largely eliminated. As the finish is protected from the hot sun and strong winds, excessive drying with consequent crazing can be largely avoided.

The dusty, chalky finish which often results from overtroweling by the cement masons of finish placed monolithic, is avoided and a denser, better wearing surface results.

The question then is one of how best to place the structural slab so as to insure an adequate mechanical bond between the base and the finish. The work most successful along these lines has been done according to the following method:

As fast as a section of concrete across the building is finished the excess water is broomed off and at night or just before the concrete finally sets, the surface of the structural slab is lightly raked with an ordinary iron garden rake. The raking should be complete enough to avoid the possibility of any smooth spot or spots of laitance on the surface of the concrete but should not be carried to such a depth that the effective section of the slab is reduced.

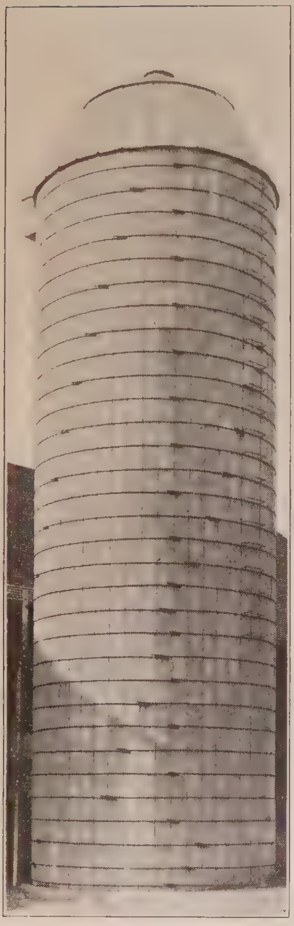
When ready to place the topping the slab should first be swept with a stiff rattan broom and be scoured with a fire hose using about a 2-inch hose with a 1-inch or 1¼-inch nozzle. With ordinary city pressure this will usually give a stream of sufficient force to thoroughly scour out the rough surface of the slab. The washing should proceed in one general direction across the building so that the dirt, sawdust, shavings, etc., which are loosened from the slab, may be washed or broomed over the edge of the structure.

A neat cement grout should then be mixed up and thoroughly broomed into the roughened surface of the slab. The grout should be mixed very stiff as, in spite of all the sweeping that can be done, there will be enough water remaining in the roughened top of the slab to thin the grout down quite considerably. The grout should be immediately followed by the topping which should be mixed just as stiff as possible. The stiffest mix that can be discharged from the ordinary drum mixer will still be found to be quite wet when placed on the floor and spread out and screeded off.

The topping mix, it has been found, should be so dry that it is necessary to hoe it down the discharge chute of the mixer and hoe it or shovel it out of the carryalls. When such a dry consistency is being used it is of course necessary to increase the time of mixing, which should not be less than two minutes and may be run up to five minutes with decided improvement in the quality of the wearing surface.

How to Make and Sell Concrete Silo Staves

A Profitable Concrete Products Specialty—Can Be Developed On a Large Scale—Types of Silo Staves—Wet and Dry Processes—Manufacturing Methods—Erection of Stave Silos—Costs—Profits—Investment Required—Some Sales Helps



THE concrete stave, while it is a comparatively youthful member of the concrete products family, has made rapid strides and is steadily growing in popularity. Not only is it used for erecting silos, but it has proved practicable for coal pockets, material bins, corn cribs, barns, hog houses, etc.

The manufacturer of concrete staves has a large potential market. Reliable surveys indicate that the silo market has been only about 25 per cent developed. The corn crib market and the other markets for concrete staves have hardly been scratched.

The manufacture and erection of concrete stave silos is a profitable venture. A silo that does not yield a net profit of from $70 to $125, depending on its size, is poorly sold.

Most silo manufacturers do their own manufacturing, selling and erecting. Such a plan has been found to be most satisfactory and profitable, especially for the products manufacturer who is just entering the field.

A concrete stave is a slab of concrete about 30 inches long, 10 inches wide, and 2½ inches thick. Dimensions vary somewhat in the different types of staves.

The edges are concave and convex or are tongued and grooved in various designs so that adjacent staves interlock and the shapes of the staves themselves vary somewhat according to the type selected.

Concrete staves must be very carefully made because of the thin walls that result from their use. The 2½-inch wall is thinner than that used in any other type of construction and in order to secure the required strength and density, it is necessary to adhere strictly to the principles that insure quality concrete. Very good quality staves have been made by both the dry tamp and the wet cast processes when care was exercised in their manufacture.

The Dry Tamp Method

When the dry tamp method is used, the concrete is mixed to a semi-plastic consistency. It is then placed in machines from which the stave can be removed as soon as it is formed. There is a tendency to use too little mixing water when this method is used. Enough water should be used so that the mix is just dry enough for the stave to retain its shape when it is removed from the machine.

True Edges Necessary

Perfectly straight edges and square corners are absolutely essential or considerable difficulty will arise in constructing the silo. The staves will not fit together snugly and are liable to crack when the hoops are tightened.

The top of the stave lies in the mold box flatwise. After the concrete has been tamped, the top surface of the stave is smoothed with several strokes of a steel trowel. Too much trowelling draws the cement to the surface and may cause checking.

Another item of importance in concrete stave manufacturing and one that has a definite effect on the speed of erection is the use of perfectly true pallets which hold the stave while the concrete hardens. If wood pallets are used they must be oiled, shellacked, or treated in some other manner to prevent warping. A warped or twisted silo stave occasions no end of trouble in erecting the silos.

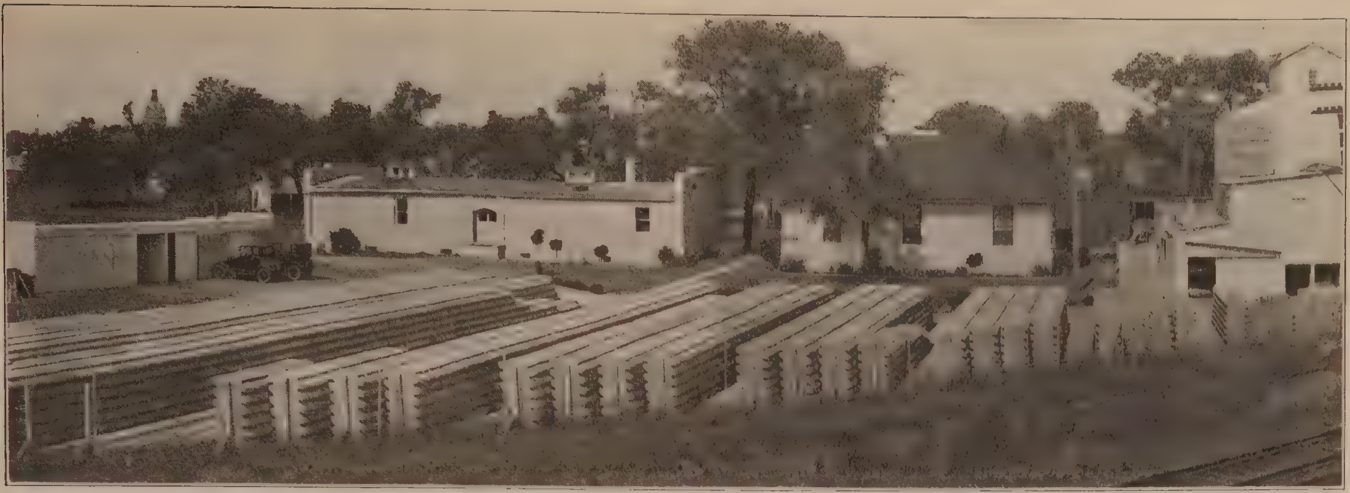
A mixture of one part of portland cement to three parts of aggregate has been found to be very satisfactory. Only fine aggregate, having a maximum size of about ⅜-inch, should be used so as to insure smooth surfaces and sharp edges. The aggregate should be well graded, that is, it should contain particles of all sizes from the finest to the coarsest. Well graded aggregates make concrete of greater strength and also of greater density.

The Wet Cast Process

When the wet cast process is used, concrete mixed to a plastic consistency is placed in gang molds, usually made of sheet metal. The use of this method tempts the manufacturer to use too much water, as the dry tamp method tempts him to use too little. Only enough water should be used to secure a concrete of a consistency that will permit placing in the forms.

The staves are allowed to remain in the molds for from 24 to 48 hours or until the concrete has hardened sufficiently to permit their removal.

When the cast method is used, both fine and coarse aggregate can be combined with the cement. Coarse aggregate up to one inch in size has been used with success. The fine and coarse aggregates should be combined in such proportions as will result in the densest concrete. Usually the proportions will be approximately 1 part of cement, 1 to 1½ parts of fine aggregate and 1½ to 2 parts of coarse aggregate.



A Kansas curing yard

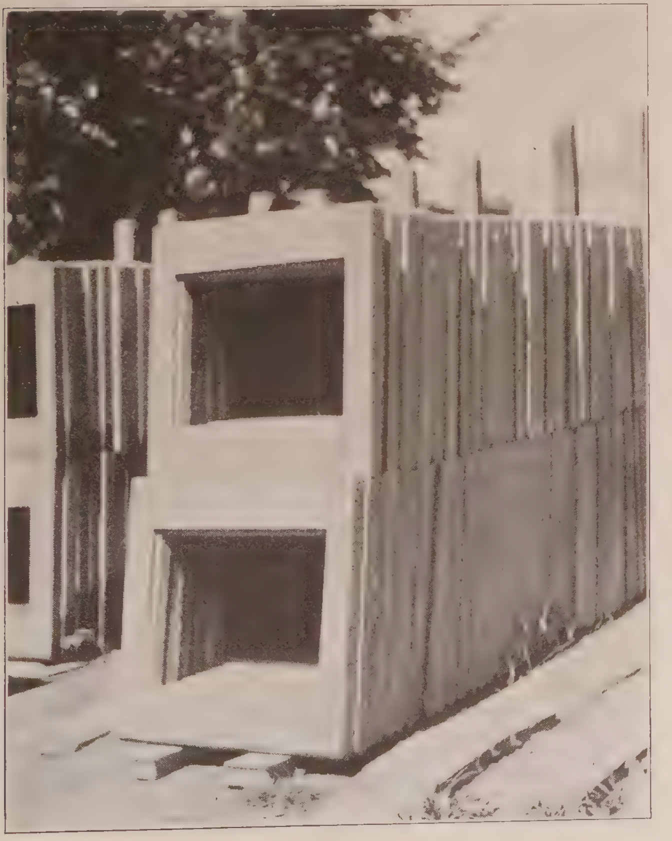
Curing

Adequate curing is of great importance whether the dry or wet process is used. Immediately after the staves are tamped or cast they should be placed in a curing room where the proper amount of moisture can be applied. After two or three days in the curing rooms they can be moved to yard storage, but then also they should be kept wet by sprinkling until they are a week or ten days old.

As many silo staves are made in the winter, it is necessary to provide curing chambers that will supply the warmth needed for winter curing.

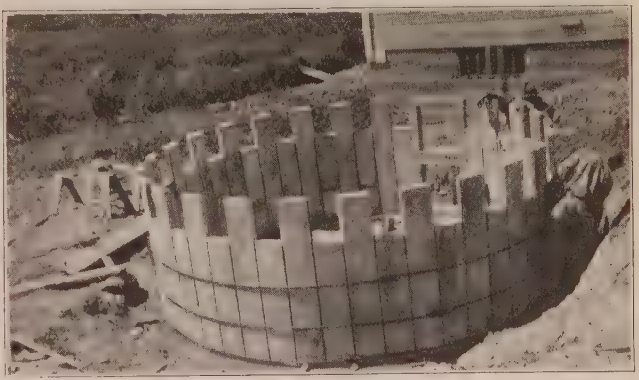
Erecting Silos

Usually when a farmer buys a silo he is impatient to have it erected as soon as possible. For this reason it is advisable to carry enough staves in stock to meet such demands. More silos are erected during the month just preceding silo filling time than during all the other months of the year combined. The foresighted manufacturer will prepare his stock for this demand upon it. The winter and spring months can be devoted to building up the stock.



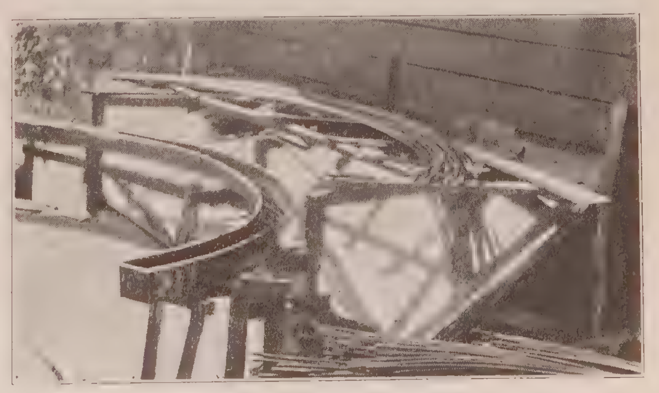
A stack of silo door frames

While this erecting season lasts, the manufacturer must devote all his resources to this activity.



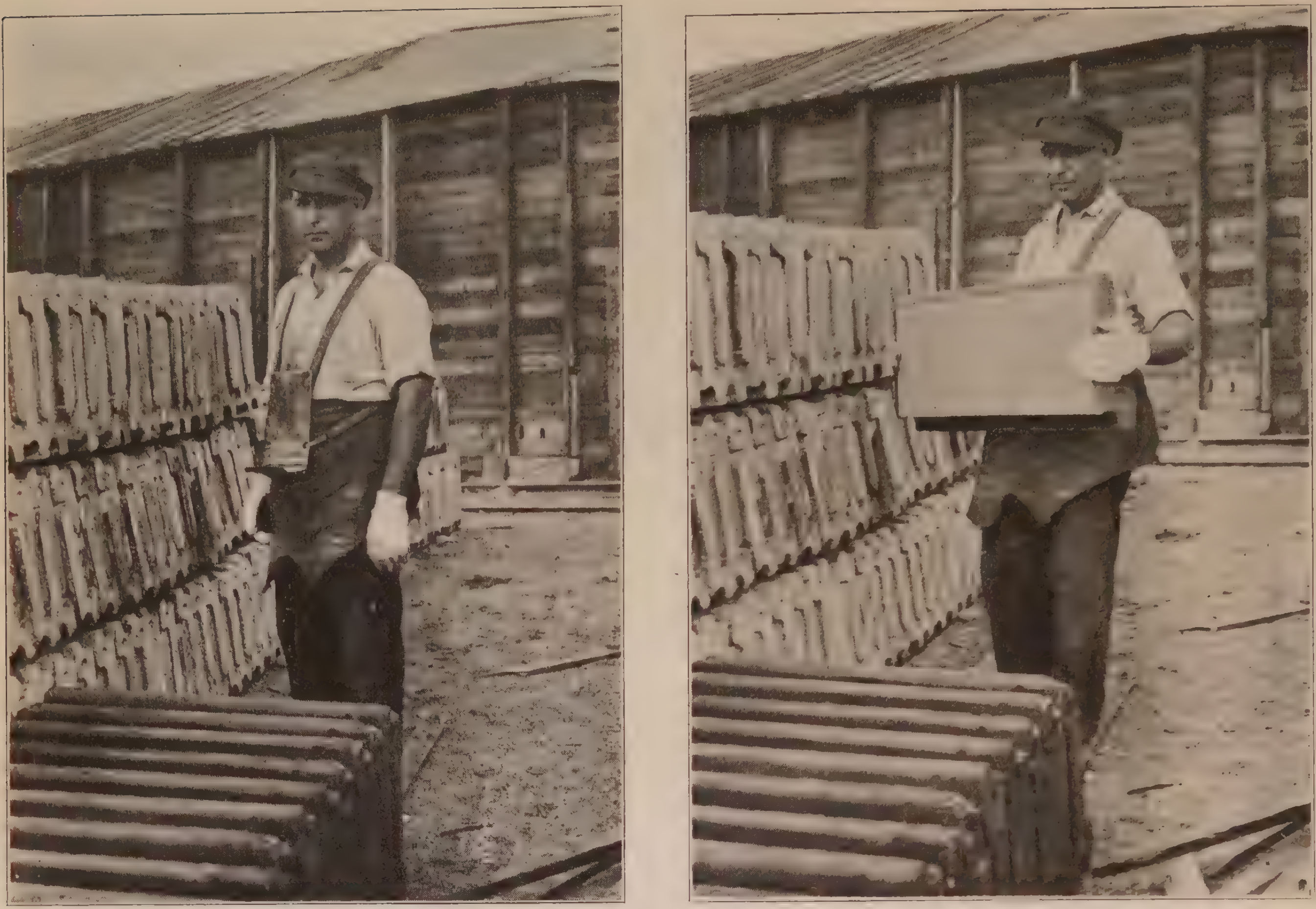
Setting up the staves

Concrete stave silos are quickly and easily erected. Three men can easily erect two average sized silos each week and some crews can do better than that, especially when the proper equipment is at hand. The concrete window and door frames used are precast, made in the plant where the staves are made.



Hoops dipped in asphaltum to protect them from rust

A light, adjustable erecting scaffold is a necessary piece of equipment. Scaffolds are of two general types—those supported by a center mast and those hooked over the silo wall. Staves are fitted to position by means of a light derrick which comes as a part of the erecting equipment.



Note the practical device the worker wears to balance the staves and how it is strapped

Concrete staves are generally set up dry, no mortar being used in the joints. In some types a groove is moulded entirely around the edge of the stave. When these staves are placed edge to edge a circular opening is left in the center of the joint which is filled with cement grout.

The hoops or steel rods, placed to reinforce the silo, are set as the erection of the wall progresses. Hoops are usually composed of two or three sections, depending upon the diameter of the silo. The sections are joined by means of special lugs. After the hoops are placed in position they are drawn tight enough to hold them in position. They should not be drawn too tight at this stage because they would draw the staves so closely together that it would be impossible to place the next course of staves. After the entire silo walls are completed, the hoops are drawn tight, care being exercised to draw them all to the same tension.

The number of hoops to be used depends on the size of the silo and the material it is to store. The silage or other material exerts an outward pressure which would burst the silo, unless the proper number of steel hoops were provided. This pressure increases in proportion to the depth of the silage. At the top of the silo, where the pressure is light, hoops are usually spaced 30 inches apart. Because the silo staves are 30 inches high, this is the maximum spacing that can be used. A little farther from the top the silos are double hooped, that is, the hoops are spaced fifteen inches apart. Some silo manufacturers double-hoop the silo for its entire height, believing that this adds to its appearance as well as to its strength. The 9/16-inch rod with rolled threads is now most generally used for silo hoops.

After the walls are erected and the hoops tightened, the interior walls are ready for a wash that seals the joints and produces a smooth, impervious surface. A cement wash, made of a mixture of cement and water and of the consistency of thick paint, is often used. It is applied to the walls with a broom or large brush. Some manufacturers prefer to add a small amount of lye to the mixture, claiming that this produces a smoother and denser surface. Care must be used not to add too much lye. Other manufacturers add both lye and alum to the cement grout.

Merchandising Suggestions

It is impossible to lay down definite rules for selling silos. Every prospect is an individual problem and must be handled as such. There are some fundamental facts, however, that every silo salesman must have at his finger tips. He must have a full and complete knowledge of the value of silage and of the savings that the silo makes available to the farmer. Preferably he should take his figures from the actual experiences of farmers in his sales area. The farmer is not going to buy a silo until he is convinced that it is going to bring him a profit.

Pictures of good looking farm silos are of assistance to enable the farmer to visualize such a silo on his own farm. Above all, the salesman must talk to the farmer in language that he understands best and use the viewpoint of the prospect.

Once one silo is sold in a neighborhood, a step has been taken to sell other silos. Salesmen should call on their previous customers to find out if other farmers have expressed interest in the new silo. Usually the man who already has a silo can give the salesman a good list of live prospects.

If possible take the man who already has a silo with you when you call on prospects in his neighborhood. One farmer will listen with attention to the experiences of his neighbor.

It is not always possible to make all of the calls on farmers who already have bought silos. Names of prospects can sometimes be secured by requesting old customers to mail in the names of neighbors who have expressed an interest in silos. The manufacturer can offer a small commission for the name of every prospect who becomes a customer.

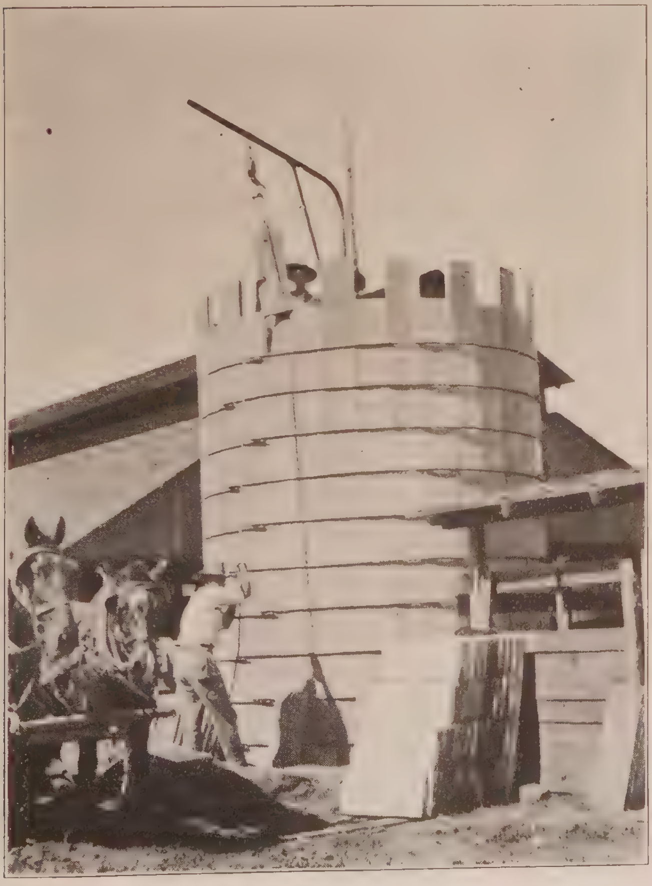
If you are just beginning the manufacture and sale of stave silos, a more difficult problem of getting prospects confronts you. It is worth while to cultivate the acquaintance and friendship of all those interested in the farmer's welfare. The county agricultural agent, the implement dealers, the country newspaper and the banker are able and willing to help you.

Bankers know, or can be convinced, that silos make for greater prosperity. Often they will give you a list of names of farmers who are logical prospects. Attendance at farmers' meetings promotes acquaintance with prospective buyers and often leads to direct sales. Consistent advertising, especially when the money value of silos is stressed, will lead to prospects and sales. Let the farmer know that there is a silo manufacturer in the community.

Every silo manufacturer should have some printed matter for distribution. The dollars and cents value of silage should be forcibly brought out in these booklets. Testimonial letters from farmers who have silos are valuable. They should contain a description of the type of silo you furnish and should bring out the advantages of your type.

Investment and Costs

An investment of from $1000 to $1500 will permit the products manufacturer who already has a plant and mixer, to begin the production of silo staves. This will include the purchase of a mold machine, a mechanical tamper, about 1000 pallets and other necessary equipment. With it, the manufacturer can turn out approximately 500 staves per day, enough for a small sized silo. He can easily manufacture enough staves for three large size silos per week.



Crane for raising staves in silo construction

Following is an estimate of the complete cost of manufacturing, selling and erecting a 14 by 32½ ft. stave silo having a capacity of 100 tons. The silo was erected in 1922 in the corn belt and the costs will serve as a basis for arriving at the cost of a silo under your present local conditions.

650 staves, 2½x10x30 inches at 25 cents each	$162.50
(Includes all manufacturing costs.)	
13 door frames (concrete) at $1.60 each	20.80
13 wood doors at $1.15 each	14.95
Steel rods, lugs and other hardware	71.97
7 sacks cement for inside wash	4.90
Total manufacturing and material cost	$275.12
Loading and transporting staves	$ 10.00
Erection of silo	50.00
Sales expense (12½ per cent of sales price)	62.50
Total cost of loading, erecting and selling	$122.50
Total cost of silo	$397.62

This silo sold for $500, leaving a margin of profit of a little over $100.

A wet cast stave silo

Concrete stave silos have an excellent reputation. They have proved themselves to be practical and economical. Many of them have weathered windstorm and fire without damage. The products manufacturer who enters the stave silo business, makes a quality product and merchandises it aggressively should find the venture as successful as other manufacturers have found it.

Concrete and Corrosion

By A. L. WALKER

Some disastrous fires have shown that properly prepared concrete, especially when reinforced, is one of the best of fire resistants but it is not generally known that this material resists the corrosive action of various chemical solutions to a very great extent. We propose to mention a few of the ways in which it has been used with regard to this property.

In the first place, the material used in the construction of a containing vessel need not be such that the liquid to be held has no chemical action thereon. Indeed, if such a rule were to be followed industrial chemistry would be in a very bad way. Very often it happens that the liquid attacks the walls with the result that a new compound is formed superficially which successfully resists further action. A common example of this is between sulphuric acid and marble. If a piece of the latter be dropped into a vessel containing the acid, chemical action starts but soon slows up and eventually stops entirely. A coating of calcium sulphate has been formed which is impervious to sulphuric acid. Again the magnesium alloys which are rapidly coming into favor for fine castings for engines are quickly affected by the atmosphere but the film of oxide thus formed is an efficient protection against further action.

Apparently the corrosion resisting powers of concrete are due almost entirely to the reasons given above since the actual constituents are themselves affected by most of the strong acids and alkalies. Generally it is not advisable to use concrete for tanks for containing either acids or some of the stronger sulphates: at any rate such use is attended with considerable risk. For other solutions, however, concrete is well worth a trial. It is not sufficient to look up a table and see if some action is predicted: an experiment is essential.

The proportions used in the aggregate are of importance to the resisting powers of the whole but again no definite laws can be stated; it is entirely a matter for experiment. The best way to start about the thing is to make up a number of different concretes and mould them in wooden boxes so that they form miniature tanks. Whatever liquid it is wished to contain can then be put in and an endurance test carried out. In this respect it should be noted that the test solutions should be of just the same strength as those which will be used in the finished tank. A slight difference in concentration often makes the ensuing action quite different. Sometimes stronger solutions are used so that the time for the experiment may be reduced. Actually, where this method is employed the test is often worse than useless.

For holding water, the usual type of concrete serves well and there is no appreciable difference even where the proportions vary between wide limits. Sometimes the inner surface is coated with mortar. It is stated that such a lining prevents the formation of slime when a certain amount of organic matter is present.

Wooden tanks are in very general use for dipping. In many cases these might advantageously be replaced by concrete which is more permanent and clean than wood. Caustic soda, calcium chloride, brine, chloride of lime and zinc chloride have all been held satisfactorily by tanks of concrete.

Nearly all the oils have no effect on concrete, which may therefore be used with confidence for vessels to hold them. If the oil happens to be slightly acid the surface may be given a coating of oil proof enamel. Unlike most of the metals, a concrete surface takes kindly to coverings of paints and varnishes. Peeling seldom occurs and so the resistive properties of the latter may be used to full advantage without failure taking place due to mechanical reasons.

On account of its cheapness, concrete should appeal strongly to the engineer. It is not used as much as it ought to be, but ignorance as to its uses for mechanical requirements accounts for this. With the reservations given above whenever a new tank is required concrete should at least be considered as in the running. Those who have used it have nothing but praise for its unchemical action.

A. S. C. E. Will Analyze Mississippi River Flood Problem at Meeting

Two days will be devoted to the topic of the Mississippi River flood problem at the annual fall session of the American Society of Civil Engineers in Columbus, Ohio, October 12th to 15th.

The meeting provides for an analysis from all points of view. Secretary of War Dwight F. Davis, and Maj. Gen. Edgar Jadwin, Chief of Engineers, will present the view of the War Department. Other government departments co-operating will include the U. S. Geological Survey, through Nathan C. Grover, Chief Hydraulic Engineer, the Mississippi River Commission through Col. C. W. Kutz, and the Interior Department, through Elwood Mead, Commissioner of Reclamation.

The various proposals for alleviating danger will be discussed. These include forestation, reservoirs, levees, spillways and auxiliary channels. Likewise the relation of the problem to various secondary phases, reclamation, power, drainage, etc., will be presented.

Following this discussion, other important national topics which will be brought up include, the wind resistance of tall buildings, highway transportation and safety, and the new waterworks for the city of Columbus.

Social events will include excursions to the Columbus water system and to the Ohio State University.

Members are advised to secure tickets in advance. The latter may be secured from F. H. Waring, Chief Engineer, State Department of Health, Columbus.

Coming Conventions

October 12th to 15th—American Society of Civil Engineers, at the Neil House, Columbus, Ohio, Fall meeting.

December 1st, 2nd, 3rd—American Construction Council, at the Hotel Statler, St. Louis, Missouri. Sixth annual convention.

January 4th, 5th, 6th, 1928—National Sand and Gravel Association, at the Book-Cadillac Hotel, Detroit, Michigan. Annual convention and machinery exhibit.

January 9th to 13th, 1928—American Road Builders' Association. Cleveland, Ohio. Convention and Road Show.

January 23rd to 27th—Associated General Contractors of America, at West Baden Springs Hotel, West Baden, Indiana. Convention and national construction exposition.

February 28th, 29th, March 1st—American Concrete Institute, at Benjamin Franklin Hotel, Philadelphia, Pa. Twenty-fourth annual convention.

The A. B. C.'s of Good Concrete

Some of the Factors That Affect the Quality of Concrete —Keeping Concrete Damp the First Ten Days After Placing Adds 75 Per Cent to the Strength of the Concrete

Part V—The Importance of Curing Concrete

Previous chapters, discussing the amount of mixing water to be used and the need of workable concrete, stressed the advisability of limiting the amount of mixing water to be used. We learned that a safe rule to follow was to use the ***smallest amount*** of mixing water that would produce a mixture plastic enough for the work in hand.

Now we do a right-about-face and urge the use of ***as much water as possible*** for curing the concrete after it has been placed. Why this is necessary and what effect proper curing has on the quality of concrete is the subject of this chapter in this series of articles written for the non-technical concretor who wants to know how to make good concrete.

THE proper protection of concrete during the early hardening period is a detail of construction that is too often overlooked by concretors. It is not enough merely to place good concrete into the forms or on the subgrade and then to forget it. The concretor's responsibility is not ended *until the concrete has hardened.* How it is treated during the first week or ten days after it is placed has a very important effect upon its strength and wearing qualities.

One of the principal causes of the poor wearing resistance sometimes found in roads, driveways, sidewalks and concrete floors is the lack of proper curing. Sometimes even when all the requirements of proper proportioning, little mixing water and careful placing are met, the resulting concrete is still away below what it ought to be because adequate curing is neglected.

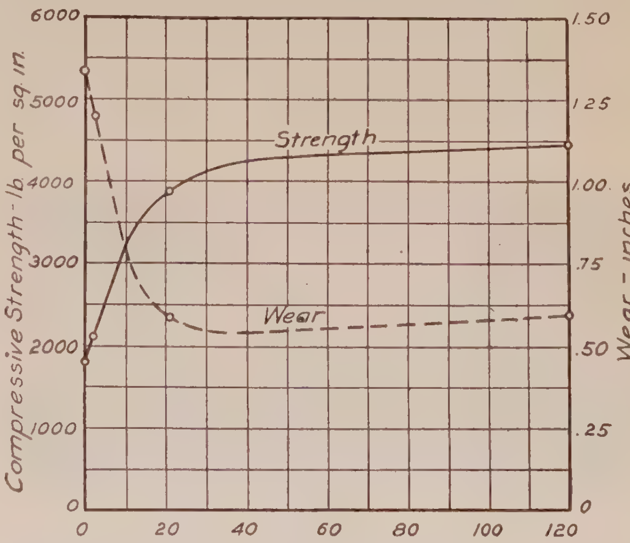
Proper curing is second in importance only to the control of the mixing water. When concrete is kept damp for the first ten days, it will be 75 per cent stronger than when it is allowed to dry out.

Concrete *does not* harden by drying out. Hardening is the result of chemical reaction between the portland cement and water. Without the required amount of water, this hardening process cannot take place. Consequently only a portion of the cement can develop strength when there is a lack of water and the concrete as a whole is weakened.

This chemical reaction of the hardening of cement is a comparatively slow process. If sufficient moisture is not at hand, it cannot be completed. Too often the mixing water needed to harden the concrete is allowed to be lost by evaporation or absorption even after the concrete has begun to harden. When this happens it is impossible for the concrete to attain its normal strength.

For these reasons it is absolutely necessary that the water content of the freshly placed concrete be conserved. This can be done by keeping the concrete damp, especially in its early hardening period when strength is developed most quickly. The need for curing applies to all classes of concrete work, whether it be roads, structures or products and the effect of proper curing is the same on all concrete no matter how it is used.

Some tests made at the Structural Materials Research Laboratory at Chicago show very definitely that the strength of concrete is materially increased when it is cured properly. It is also shown that there is a direct relation between the strength of concrete and its resistance to wear. When other factors are the same, concrete that has been cured will show a much greater compressive strength and much less wear than concrete that has been allowed to dry out too rapidly.



The accompanying chart shows a summary of the results of the test. All of the specimens were tested at the same age—four months. The difference was that the specimens were stored in damp sand for different periods of time. One set of specimens was not cured in damp sand at all; the second set was stored in damp sand for three days and in air for the remaining 117 days; the third set was stored in damp sand 21 days and the fourth set was stored in damp sand for the entire four months. The curve shows the results of the various curing periods. Note that when the concrete was stored in damp sand for ten days, its compressive strength was increased 75 per cent. Specimens stored in damp sand for three weeks increased 115 per cent in strength and those stored in damp sand for the entire four months were 145 per cent stronger than the specimens that were not cured in damp sand at all.

Similar results were found in the wear tests. Ten days' curing increased the resistance to wear 65 per cent and three weeks' curing increased resistance to wear 120 per cent.

The slight additional cost of proper curing is very insignificant compared to the results it brings.

The principal requirements for proper curing are the presence of moisture and warmth.

There are several methods of protecting the concrete against loss of moisture during warm weather and against freezing in cold weather. The type of structure built will, of course, determine the curing method to be used. Concrete products are usually cured in specially constructed curing rooms in which a water spray or steam spray supplies the necessary moisture and warmth. Even after they are taken from the curing rooms to yard storage, it is worth while to keep them wet by sprinkling until they are at least ten days old.

Applying burlap

Concrete pavements are cured by several methods. As soon as the concrete on the subgrade is placed and finished, the surface should be covered with wet burlap which can be sprinkled at intervals with water from a fine spray nozzle. After the concrete has hardened sufficiently a covering of earth or straw can be placed directly on the concrete. This covering should be kept wet for a period of from ten days to two weeks.

Covering with straw

Similar methods can be used for curing concrete floors. Vertical surfaces can be kept damp by frequent sprinkling of the forms or the exposed concrete. Sometimes walls can be covered with canvas or burlap which is kept drenched with water.

Wall finishes such as stucco are particularly in need of curing. They must be carefully protected from the sun and wind during their early hardening period. They should be sprinkled at least once each day.

Winter Curing Conditions

When concrete is placed during cold weather, the curing period is doubly important. It is necessary then to provide means for keeping the concrete from freezing as well as to retain the moisture necessary for the chemical reaction of hardening.

Concrete will develop its strength faster at higher temperatures than at lower temperatures. Temperatures below 50 deg. Fahrenheit slow up the hardening process noticeably.

It is therefore advisable to make provision for keeping the concrete at a temperature of 50 degrees or more during the hardening period. There are two general methods in use to attain this end. Either the aggregates and water used are heated or the structure itself is heated after the concrete is placed in the forms. Sometimes both methods are used.

A covering of marsh hay one to two feet deep is a good protective measure

Devices for heating aggregates and water are available and have often been described. There are several types of enclosures that have been devised for retaining heat in and around concrete structures. Their purpose is to protect the concrete from freezing and to permit the hardening process to go on without interruption.

It is important when these methods are used to insure against too rapid drying out of the concrete. The heat supplied hastens the drying out of the concrete as well as keeping it from freezing. It is necessary in such cases to keep the concrete wet by one of the methods used to cure concrete in warm weather.

Tarpaulins usually prove to be a good investment

The importance of proper curing cannot be overestimated. Yet it is one of the details of construction that is often neglected. The cost is comparatively slight and the returns in greater strength and resistance to wear are more than enough to repay the concretor for giving this item his most careful attention.

Relation Between the Characteristics of Portland Cement *and* Deterioration of Concrete

Water Travel in Concrete Causes Deterioration—Formation of Needle Crystals in Concrete—Efflorescence—Reaction of High Calcium Cement Compounds with Other Widely Distributed Compounds

By JOHN R. BAYLIS
Filtration Engineer, Bureau of Engineering, City of Chicago, Ill.

Part IV—The Effect of Neutral Salts on Concrete

HYDRATED portland cement is a heterogenous mixture of several chemical compounds in which none of the main compounds are in a condition of stable equilibrium unless protected. There is hardly a calcium compound in cement that will not give up calcium to carbon dioxide, which means there is no hydrated cement that remains in its original composition at the outside surface of concrete. The depth to which this change takes place largely depends on the porosity of the concrete. The writer hopes the engineer will grasp the full significance of these statements, for the original cement compounds which gave the concrete its binding power have undergone chemical changes and they no longer remain the hydrated cement compounds. Hydrated cement probably is one of a few products that can undergo such wide changes with little or no effect on the strength. When the concrete is exposed to water corrosive to calcium carbonate calcium is washed away in addition to other changes and in this case there may be a great reduction in strength.

Water Travel in Concrete is Responsible for Most Concrete Deterioration

If there were no movement of water within the pores of concrete it would very likely retain its strength a great many years, for deterioration would have to take place from the outside inward. A concrete wall with water on one side may appear dry on the outside, yet if the concrete is not coated with an absolutely water-tight membrane, water is likely to evaporate from the outside surface. It is only when it is passing through faster than it is evaporating that signs of leakage are noticed. If durable concrete is desired the water should be kept motionless within the concrete.

Engineers should keep in mind the fact that there is very little durable concrete where water can travel in it, even when the travel is due to capillary attraction caused from moisture evaporating from the concrete surface.

So often do we cut into old concrete and are amazed at the ease with which it can be cut. Was the concrete originally this weak, or has it deteriorated in strength? Undoubtedly much of the weak concrete has been weak since construction, but there are many cases where it is known that deterioration has taken place. In practically all such instances the cause can be attributed to water travel in the concrete. The large amount of sodium carbonate and sodium sulphate crystallizing on the surface, which is shown in Figures 9 and 10, give evidence that the water from the interior has been traveling to the surface where it is evaporating. The rate of water travel due to evaporation is greater than the diffusion rates backward.

Practically no concrete is constructed that contains compounds, with the possible exception of sodium and potassium, that are seriously detrimental to it if they remain evenly distributed. Unfortunately the even distribution does not long remain when water can get to the concrete at certain points and is evaporating at other points. The effect of certain salts in solution or in the

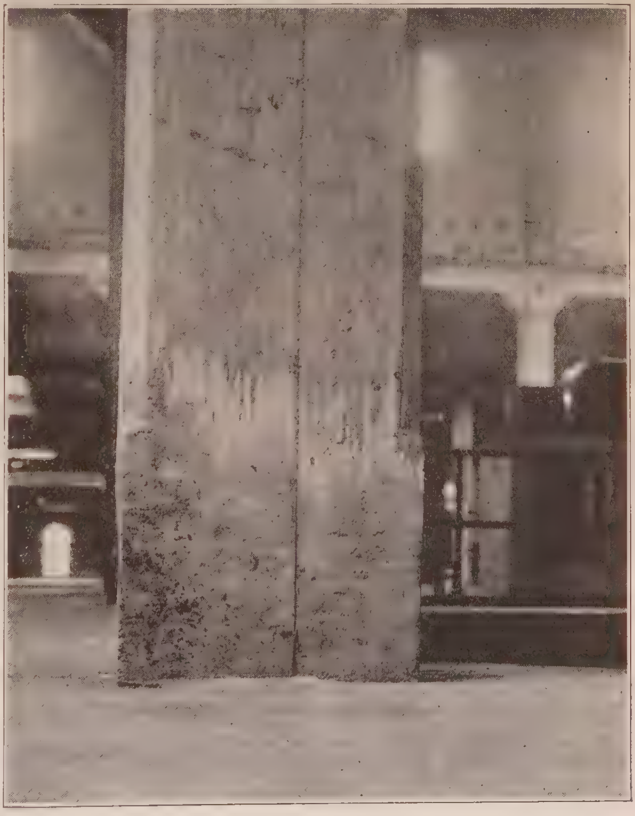


Figure 9

concrete compounds then is not the weak dilution found in the water entering the concrete, or the small percentage in the concrete compounds, but the effect of strong solutions at the points of concentration.

It is well known that certain compounds, when sufficiently concentrated in the solution, are very detrimental to concrete, yet it seems that no one gives much thought to the effect of the white efflorescence of sodium carbonate and sodium sulphate on the surrounding concrete. The writer had occasion to take a trip in the early spring of 1926 during which many structures containing exposed concrete were seen. There was not a single one that did not have part of the concrete showing the white efflorescence somewhat as shown in Figure 11. The efflorescence is not confined to the concrete, and is probably more abundant on brickwork. However, the cause of the concentration is the same—that is, water travel through the concrete or brickwork. A section of the concrete part of the wall shown in Figure 11 is shown in Figure 12. This was originally very good concrete, but after 11 years' exposure to the water there is no difficulty in cutting a hole through it at the water line with a pick. Fortunately the wall is where very little strength is required, for it is doubtful if the concrete now has one-fourth of its original strength.

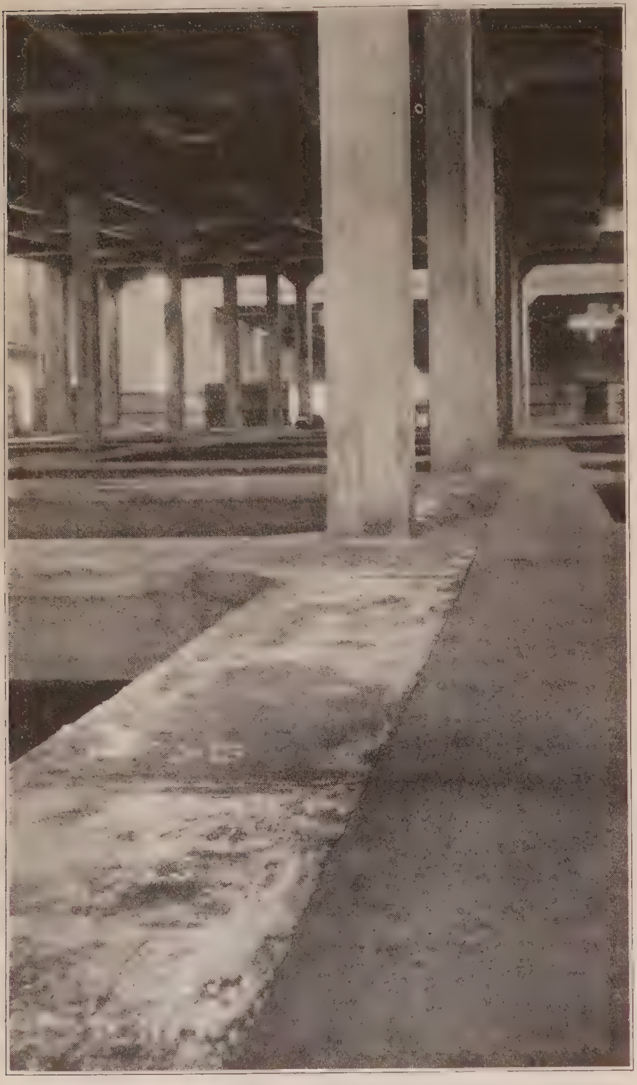


Figure 10

What changes have taken place in the concrete to produce this deterioration? Examination of the concrete did not reveal a great number of calcium hydroxide crystals, and all evidence indicates that hydrolysis played no material part in the deterioration. The enormous number of calcium sulphoaluminate crystals indicates that the formation of this compound has at least played an important part in the deterioration.

Calcium Sulphoaluminate

It has been known for many years that calcium sulphoaluminate is frequently found in concrete. No reference in the literature, however, has been found as to the exact cause for the formation of this compound. It is believed that the formation of needle crystals like those shown in Figure 13 is far more serious than is generally believed. No weakened or disintegrating concrete, where it is known that the disintegration has taken place only after the concrete had weakened, has been found that did not contain an abundance of these crystals. This applies to submerged concrete or where it is moist all the time, and to concrete where the calcium has not been extracted or carbonated to the extent of reducing the calcium hydroxide

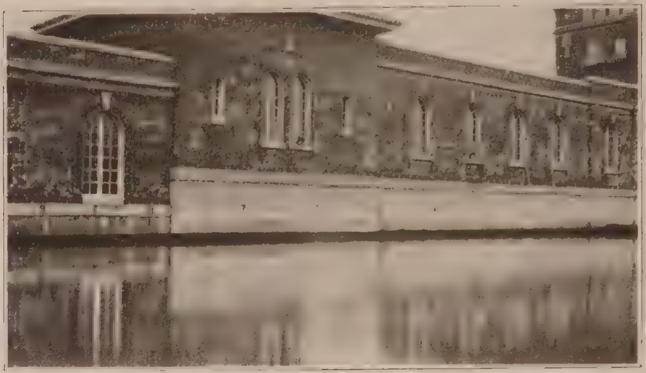


Figure 11

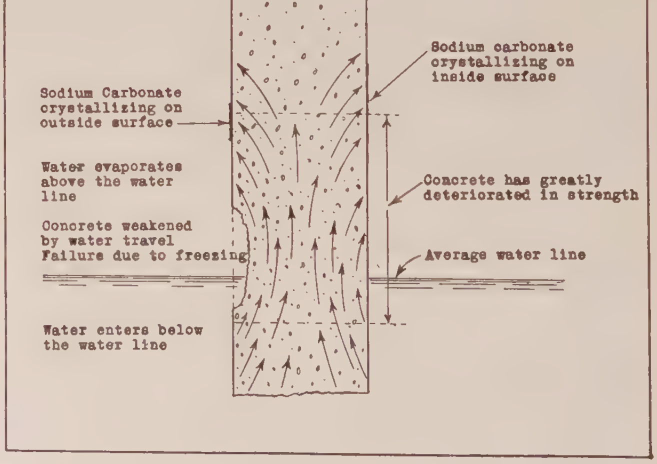

Brickwork
Sodium carbonate crystallizing on inside surface
Sodium Carbonate crystallizing on outside surface
Water evaporates above the water line
Concrete has greatly deteriorated in strength
Concrete weakened by water travel
Failure due to freezing
Average water line
Water enters below the water line

Figure 12

concentration below the point necessary for the compound to form. In some instances there has been such a large number of these needle crystals in proportion to the balance of the cement as to indicate that considerably over one-half of the alumina has been converted to calcium sulphoaluminate. It does not seem possible for this to happen without producing deterioration of the concrete. The fact that this compound can be formed in one part of the concrete by diffusion of compounds dissolved at other points where carbon dioxide has gained access to the concrete makes it all the more serious. In other words, it is not necessary for the concrete to come in contact with water containing sulphates for this change to take place. In this case, however, excessive deterioration of the concrete would be limited to points where there is concentration due to water travel.

Why Needle Crystals Form

For the past few years the writer has been trying to work out the conditions under which the needle crystals form in concrete. This has been somewhat difficult, for a three-component compound appears to be influenced by the concentration in solution of any one of the components. With an abundance of soluble alumina and sulphates, there is a minimum concentration of calcium hydroxide in which the needles will form. There is also a minimum SO_3 concentration with an abundance of calcium hydroxide and soluble alumina. In concrete there is usually a very small amount of both the SO_3 and soluble alumina, but it is likely that there is always sufficient soluble alumina in the concrete. The solution within the pores of submerged concrete is usually deficient in SO_3, and as a result the needle crystals do not form unless there is an increase in the SO_3. If SO_3 is present in solution in more than three or four parts per million and the calcium hydroxide concentration is more than one-third saturation, such crystal will almost invariably form.

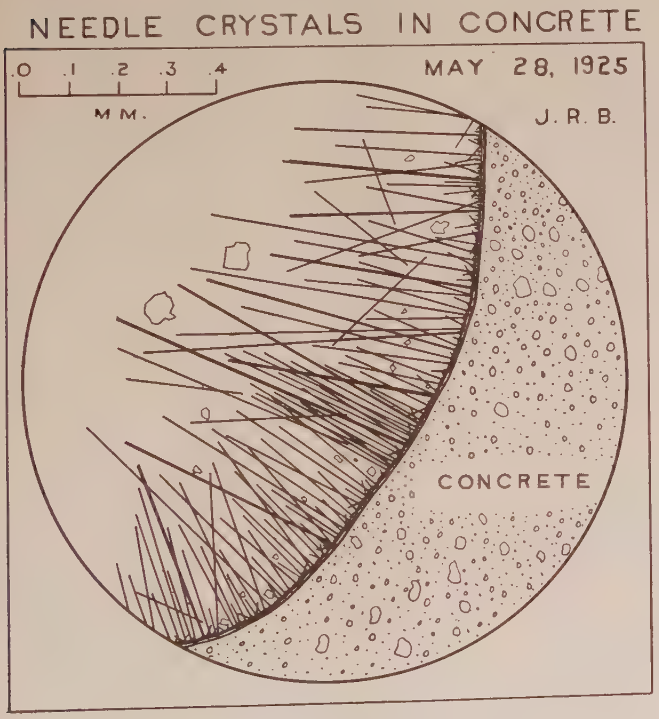


Figure 13

There are two, and possibly three ways in which the SO_3 is usually increased in certain portions of the concrete. The concrete may come in contact with water containing sulphates, or the high calcium cement compounds containing the sulphate added to control the set may be carbonated near the surface of the concrete and the sulphate released from this combination. The released sulphate may then diffuse to where conditions are favorable for the formation of the needle crystals. A third possible way is for gases containing sulphur compounds to come in contact with the concrete. The extent to which hydrated cement will adsorb or combine with SO_3 has been determined. In many tests the SO_3 remaining in solution after equilibrium has been established was found to be less than 4 parts per million.

Table III shows that with the addition of considerably more calcium sulphate to concrete than is usually added to control the set the SO_3 will continue to go into chemical combination. It will be seen from the table that the cement, in addition to containing 1.9 per cent of SO_3 originally, has combined with about 6.3 per cent more, making a total of 8.2 per cent. It might be said that when the alumina in concrete exists as some high calcium compound above monocalcium aluminate it will unite with at least twice its own weight of SO_3 before some condition of stable equilibrium is reached in which no more SO_3 will go into chemical combination. It is needless to say that this will cause distintegration of the concrete.

Table III

Combination of Calcium Sulphate with Hydrated Portland Cement

Two hundred grams of portland cement were placed in a two-liter flask and the flask filled with distilled water. The flask was agitated frequently for 24 hours to prevent lumping. Calcium sulphate (plaster paris) was then added, one gram at a time. Fifty cc. portions of the clear solution were tested after every addition of the calcium sulphate. The SO_3 as given is only approximate, as it was determined by the turbidity produced.

Total Grams of $CaSo_4$, ½H_2O Added	Time Standing After Last Addition of $CaSO_4$	P. P. M. of SO_3 in Solution
	Hours	
0	24	0 trace
1	4	5
2	20	7
3	24	6
4	24	5
5	24	4
6	24	4
7	96	4
8	24	5
9	24	5
10	24	4
11	24	5
12	24	4
13	24	8
14	24	6
15	24	10
16	48	10
17	48	18
18	72	25
19	72	30
20	96	34
	Days	
21	15	10
22	14	15
23	40	2

The Effect of Chlorides

Calcium chloride is very soluble and can be added to concrete with less danger of causing deterioration than some of the other neutral salts. The chlorides, to a certain extent, unite with the calcium aluminates and will cause disintegration of the concrete if present in higher concentrations. This has been proven positively for concrete containing the high calcium aluminates. After most of the calcium in the concrete has been carbonated it does not seem to have much effect. If a 20 per cent solution of calcium chloride will cause the disintegration of concrete containing high calcium compounds of alumina, then when calcium chloride is used in concrete it seems possible for it to concentrate in excess of this strength solution near where moisture is evaporating.

Other salts such as sodium carbonate and sodium sulphate readily concentrate to the crystallizing point, and there is no reason why calcium chloride will not concentrate to a certain extent. The writer is not aware of any concrete deterioration that can be traced definitely to the use of calcium chloride. However, no concrete where calcium chloride was used has been examined. The use of calcium chloride for most structures should not be condemned without more evidence than is now available, but it should not be used on any important exposed structures where there is likely to be water travel in the concrete due to moisture evaporating from the surface.

When sodium or potassium chloride come in contact with the high calcium compounds of cement there is a combination of a little of the alumina with the chlorides, which liberates sodium or potassium hydroxide. When present in small quantities this probably has no material effect on the concrete, but the tendency is in the direction to weaken it. Chlorides are not nearly so dangerous to concrete as the sulphates, unless the concentration is high.

Magnesium Salts

Magnesium sulphate is generally thought to be the most destructive compound there is to concrete exposed to sea water. The writer does not agree in full with this opinion. It is true that all magnesium sulphate gaining access to concrete containing high calcium compounds remains there, for the SO_3 unites with the aluminum compounds and the magnesium hydroxide is precipitated. In water works practice magnesium hydroxide is found to be soluble only to 4 or 5 parts per million in a solution containing a small amount of calcium hydroxide, and it is likely that it is even less for a solution nearly saturated with this compound.

Calcium Sulphate Formed

The addition of a considerable amount of magnesium sulphate to concrete will at first form calcium sulphate, but when the concentration is very low as it is in most concrete exposed to water containing magnesium sulphate the reaction is believed to be direct with the calcium aluminates. It is likely that sodium chloride plays a greater part in the deterioration of concrete exposed to sea water than magnesium sulphate. Tests as ordinarily conducted on concrete do not take into consideration the concentration of chlorides, and when analyses are made that show an increase in both magnesium and the sulphates, magnesium sulphate is held responsible for the deterioration. So far, the writer has not found a way of accurately determining the chlorides in concrete, except by a very slow process of repeated extractions and testing the solution for Cl_2.

The following chart summarizes the reactions of the high calcium compounds in cement with certain neutral or nearly neutral salts and gives the main product of the reaction:

Reaction of the High Calcium Cement Compounds with Certain Widely Distributed Compounds

Compound	*Cement Compound with Which It Will Most Likely Unite*	*Proportion of the Cement Compound That Will Likely Enter into the Reaction*	*Main Products of the Reaction*
Carbon dioxide	Practically all the alkaline cement compounds	Nearly all the calcium and other alkalies will be carbonated	Calcium carbonate Aluminum silicate Hydrous oxide of silica (2) Calcium sulfate
Calcium sulfate	Calcium aluminates	Nearly all high calcium aluminates	(1) Calcium sulfoaluminate
Magnesium sulfate	Calcium aluminates Calcium silicates	Nearly all the calcium and aluminum in the cement compounds	(5) Magnesium hydroxide (1) Calcium sulfoaluminate Possibly magnesium silicate
Sodium sulfate	Calcium aluminates	Nearly all aluminum	(3) Sodium hydroxide (1) Calcium sulfoaluminate Sodium aluminate Sodium silicate
Calcium chloride	Calcium aluminates	Large portion of the aluminum	(4) Compound not known, but it is some calcium compound of alumina containing Cl
Magnesium chloride	Calcium aluminates Calcium silicates	Part of the high calcium aluminates and silicates	(5) Magnesium hydroxide (4) Calcium compound containing aluminum and chlorides
Sodium chloride	Calcium aluminates	Small portion of the high calcium aluminates	(3) Sodium hydroxide (4) Calcium compound containing aluminum and chlorides

(1) Very detrimental to concrete.
(2) Very detrimental if carried to where the high calcium compounds are present.
(3) Slightly detrimental due to throwing aluminum and silica in solution.
(4) Detrimental if in large quantities.
(5) This compound may crystallize under pressure, otherwise it is not detrimental.

It will be noticed that the high calcium aluminates are decidedly the most active compounds in concrete.

Boston Products Association Elects Officers

The following officers have been elected for the coming year by the Concrete Products Association of Greater Boston: P. L. Hunt, president; Charles M. Simpson, secretary; R. W. Prescott, treasurer. For the board of directors the following were elected: John M. Simpson for three years; Thos. DeNofrio for two years, and Frank Mazza for one year.

Elkins Park, an All-Concrete Development

Philadelphia Suburban Development Illustrates Possibility for Beauty in Concrete Houses

FEW more striking examples of the suitability of concrete for a variety of public and private building purposes can be found than the Stevenson Development at Elkins Park, Pennsylvania, a Philadelphia suburb. Concrete has been consistently used throughout—for pavements, private drives, curbing, sidewalks, terrace steps and curbs, lighting standards, houses, private garages and a large co-operative apartment.

The Stevenson Development, of which Mr. Gursey Stevenson and associates are owners, are building and managing the enterprise, with D. A. Rosenstein, a well known Atlantic City architect in charge of planning, design and construction.

As the development syndicate caters to a select patronage, plans were made to improve the area entirely before offering the houses or apartments to the public. An endeavor was made to follow the most approved concrete practice and to provide the very best in other materials and workmanship as well. There are 1000 feet of one course concrete streets built in accordance with the Illinois state highway specifications, 50 feet in width. The curbs, without gutters, are 8 inches thick. Sidewalks are uniformly 5 feet wide, 6 inches thick.

Concrete Block Houses

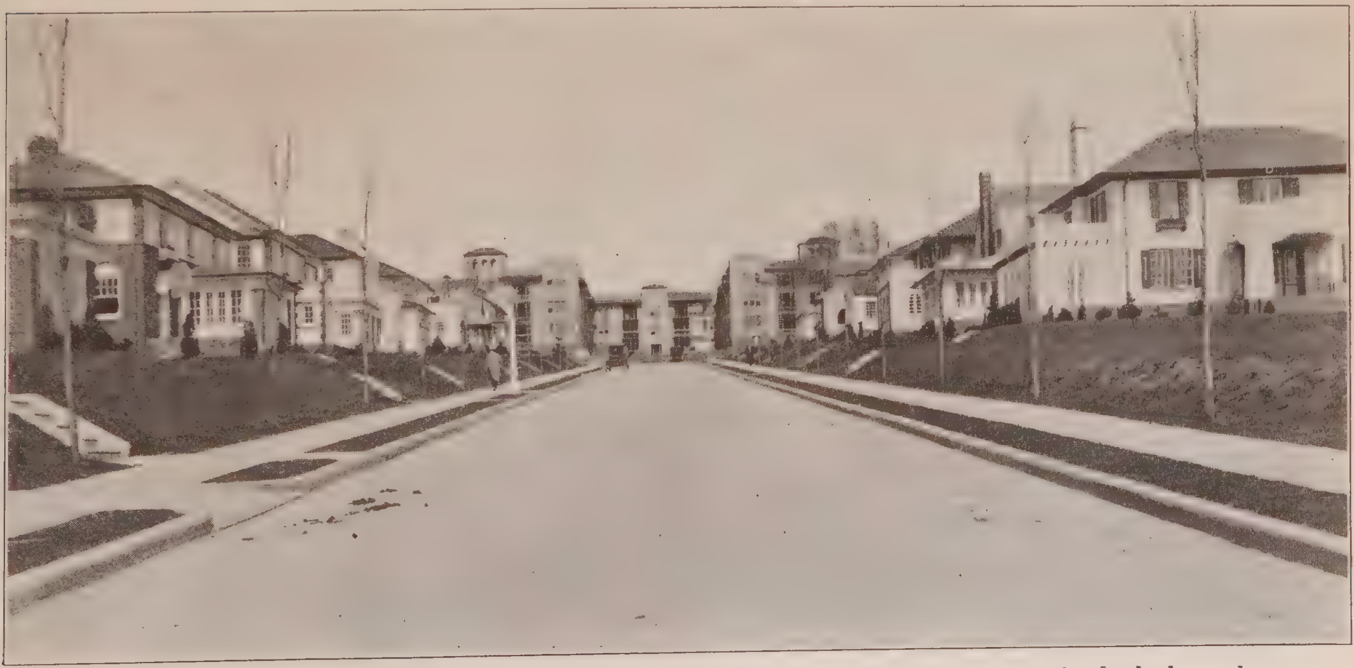
The houses in this development are unusually attractive as accompanying illustrations show. Fifteen residences, to sell at prices ranging from $25,000 to $35,000 have been completed. Cinder-slag concrete block were used in all of the bearing walls and principal partition walls, having been selected because of their fire safeness, convenient nailing feature, and moderate cost. The desire to use precast reinforced sills and lintels was also a factor, these heavy members being more conveniently seated on concrete block walls. Over 50,000 8x8x16-inch units were used in the fifteen houses, in addition to narrower and fractional length material employed in partitions and as specials.

In order to avoid any possibility of monotony the architectural style of the houses was varied sufficiently to give several distinctly different types which, however, blend attractively in the grouping. Several different materials are used in charming combination, furnishing the variety of color, texture and shadow required to obtain a snappy, although dignified and harmonious effect throughout. Portland cement stucco applied to the blocks is used for the principal exterior area of most of the houses. Some are covered more or less with a veneer of face brick, the combination of the latter with stucco being particularly pleasing. On most of the stucco covered houses face brick has been used for a short distance above grade, or for sills or ribbon courses designed to produce contrasts or outlines. Cast stone is used generously in the architectural trim, and with pleasing effect.

Concrete Brick Garages

Private garages were built for all of the residences. These are of two car or greater capacity, with walls entirely of concrete brick. Over 100,000 brick were required for the purpose. Automobile drives are all of the ribbon type, 18 inches in width and 6 inches thick. The garages are particularly good looking having flat roofs with attractive overhanging cornices.

The Elkins Court Apartments, shown in two of the accompanying illustrations, is undoubtedly the most in-



A view of a section of the Stevenson development. The Elkins Court apartments are seen in the background teresting feature of the development. Planned by Roy G. Pratt, the original co-operative apartment designer of Philadelphia, and built by Alexander Chambley, apartment builder of Philadelphia, who has built many other large apartments of concrete block and stucco, it is an outstanding structure in the vicinity. Foundations are of natural stone quarried locally, the upper walls, stair towers, chimneys, principal partitions, fireplaces, incinerator chutes and other details are of cinder slag concrete blocks of which some 45,000 8x8x16-inch units were used. Stucco was used on the exterior in conjunction with cast stone architectural trim, furnished by the Romberger Cast Stone Company of Allentown, Pa. In connection with the apartments there is a private driveway approximately 500 feet long, 18 feet in width, one course slab construction, 8 inches thick.

The Elkins Court apartments during construction

Engineer Reports Concrete Ships Are Holding Up

That concrete ships have not proven unsuccessful is evidenced by three examples built during the World War period. Government engineers report that the concrete hull of the "S. S. Atlantus" is in good shape with no sign of spalling or corrosion of reinforcement. The "Peralta" is reported also to be in good condition.

The "Palo Alto," constructed on the Pacific coast in 1919, during a recent inspection showed no evidence of disintegration.

A variety of architectural design and surfaces was used

Typical concrete masonry residence in Elkins Park, showing use of textured stucco, cast stone and veneer face brick

Oldest Concrete Work in United States Unearthed After 158 Years

Irrigation Ditch and Dam Built in 1769 Near San Diego by Franciscan Padres—Used Hydraulic Cement Made Near Job—Structures Are Still in Good Condition

By H. H. DUNN

ENDURING the wear and tear of rains, sandstorms, winds and floods, and withstanding earthquake shocks and landslides, what is believed to be the oldest concrete work done by white men in what is now the United States has been unearthed near San Diego, California. It consists of a complete irrigation system which, beginning in 1769, for a number of years carried water from the San Diego River to the Mission of San Diego, where it supplied the domestic needs of priests and Indians and also irrigated the gardens of the Mission establishment.

The dam and canal are still in good condition, save where, in the former, the wooden floodgates and their frames have rotted away, and, in the latter, the flat stones have broken from the concrete where the aqueduct was carried across a gully. The priests at the Mission, who seemed to have learned how to make their concrete from the building Indians of Mexico, whence most of the padres came, directed the 1500 Indians at the Mission of San Diego in the making of a form of hydraulic cement from the limestone deposits of the region.

Cement Made Near Job

With this cement, carried in baskets on the heads of the Indians for a distance of three miles from the limestone quarry, a diversion dam, 224 feet long, 10 feet thick and 15 feet high was built in a bend in the San Diego River, five miles from the Mission. The foundation of this dam was of huge boulders, laid loosely together, and the fluid concrete then poured thickly between the stones.

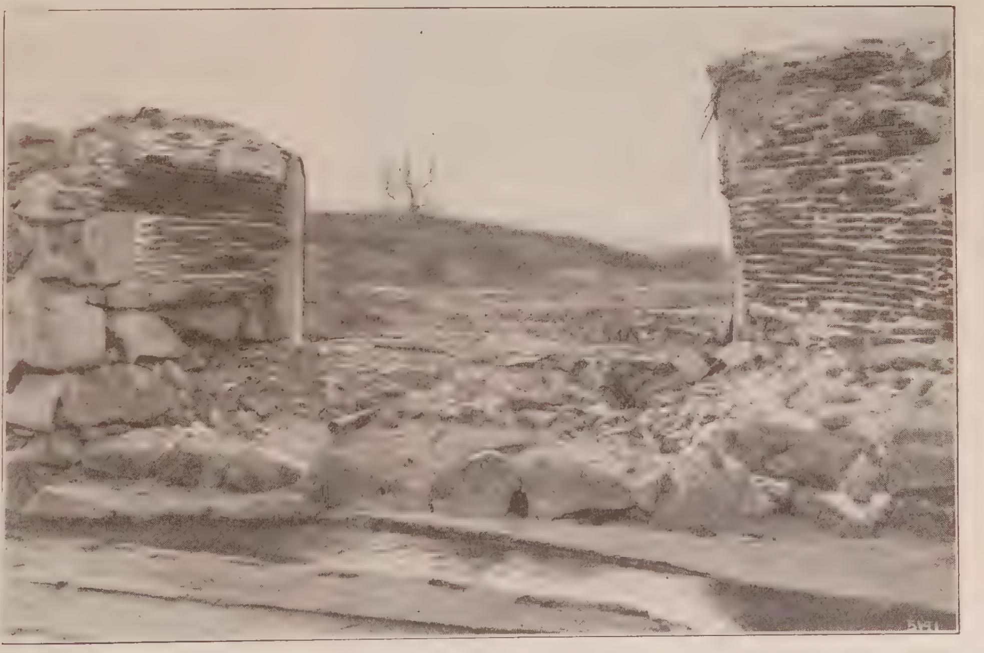
Flat slabs of stone then were collected, and the superstructure of the dam erected of these, all bound together with concrete.

Reserve Water Supply

No attempt was made to hold the full flood waters of the river, especially during the rainy season, but an abundance of water was diverted, and held in restraint, to furnish a steady and adequate supply for the Mission all the year round. A large gate was provided for the release of the flood waters, and similar, but smaller, wooden gates controlled the supply of water to the canal and to the Mission gardens. Sufficient water was handled to irrigate approximately 1,000 acres, and the actual building of the whole system was done by ignorant Indians, equipped with wooden shovels, stone hammers, triangular stones for trowels, closely woven baskets in which to carry the cement, and open-air stone furnaces, in which the lime was burned.

Still in Good Condition

The canal, leading from the dam to the Mission, is five



The main floodgate of the concrete and stone diversion dam. Though built in 1769 with a crude cement mortar, the dam is still in good condition. This project probably is the first use of cement in what is now the United States miles long, almost to an inch, and follows the shortest, most direct line between the two points. The course for it was excavated in the ground, except where it was necessary to cross two or three arroyos, or gullies, where the concrete was trusted to hold the heavy stone aqueduct—and did hold it until allowed to fall into disrepair, probably about 1825. It is certain that the irrigation system was in use for the greater part of half a century.

This canal is two feet deep, two feet wide at the top, and about 16 inches wide at the bottom. It is made of natural flat slabs of stone, about two inches thick, set at an angle in a ditch, the bottom of which was earthen, half-circular tile, filled with concrete, into which the lower ends of these slabs were sunk. The space back of the slabs, between the stone and the earthen wall of the ditch, was filled with fine gravel and concrete, the former brought miles from the river bed, in baskets on the heads of the Indians. The slabs were then bound together and faced with the concrete, and the bottom rounded up with more concrete.

A section of the first concrete aqueduct built by white men in the United States. It is five miles long and was used to carry water to the Mission of San Diego

So perfectly were the lines run, with nothing more than the very crudest of home-made surveying instruments, and so perfectly has the cement work held for more than a century and a half, that except where the canal crosses an arroyo, the aqueduct is still in serviceable condition. It is being completely excavated, and the dam repaired, to be preserved as a historical monument, and used again to carry water to the Mission gardens.

Without concrete, it would have been difficult to build this irrigation system. Without the dam and canal, the growing of food for an army of more than 1,000 men and their horses, at the San Diego Mission, likewise could not have been done. Without such a force, the chain of 21 missions which followed the San Diego Mission up the coast of California, could not have been established. Thus, indirectly, this first making of cement by white men in what is now the United States, was responsible for one of the most interesting, historical, agricultural and religious movements ever undertaken in the Far West, if not in the world.

The river has changed its course slightly, but enough to escape the dam, yet the dam and the canal are still in excellent condition, so far as the concrete is concerned, at least, 158 years after they were built. And the name of the builder, Father Garte, should not be forgotten, for he it was who introduced concrete to the irrigation systems of the West. Indeed, he may be said to be the father of all the great concrete dams which now impound billions of acre-feet of water annually for the fertile farms and orchards of the Pacific slope.

Unusual Bridge Test

An unusual "test to destruction" is about to be made on a concrete bridge spanning the Yadkin River between Albemarle and Mount Gilead, North Carolina. The opportunity is presented because of the prospective flooding of the surrounding area through the building of a large power dam, now almost completed. The impounded waters above the dam would result in complete submersion of the bridge, and a new span must be built to take its place.

Erected in 1922, as a part of the Federal Aid Highway System of North Carolina, the bridge has a total length of 1069 feet from face to face of the end bents. There are three open-spandrel arch spans of about 150 feet each, and fourteen T-beam or deck-girder spans of approximately 40 feet each.

The wrecking of the bridge affords an opportunity seldom offered for engineering tests to determine the staying powers of a structure of large size and modern concrete construction. For the purpose of taking full advantage of the situation, an agreement has been made by the State Highway Commission with the United States Bureau of Public Roads for making as complete tests as possible before the bridge is submerged. It is believed that the results will be of great value to the engineering profession in connection with bridge design and structural features.

The test to destruction will be co-operative, directed by representatives of leading technical organizations. The advisory committee will be made up of engineers appointed by the American Association of State Highway Officials, the American Society of Civil Engineers, the American Railway Engineering Association, the American Concrete Institute, the Highway Research Board, the United States Bureau of Standards, the American Society for Testing Materials, the University of North Carolina, and the North Carolina State College. This committee will formulate the test program and direct the technical phases of the work. The program will be financed and carried out by the North Carolina State Highway Commission and the United States Bureau of Public Roads.

The loading tests will be started as soon as the bridge can be closed to traffic, and will continue until the time at which the bridge becomes submerged by the waters impounded by the new dam. The limited time makes it necessary that a complete program of operations shall be prepared in advance, to obtain best effects from the exceptional investigation.

A Constant Temperature Moist Closet

Description of a Moist Closet Designed and Built for the New Hampshire Highway Department for Concrete Tests

By **WALLACE F. PURRINGTON**
Materials Engineer, New Hampshire Highway Department

THE testing laboratory of the New Hampshire State Highway Department recently found it necessary to design a moist closet to meet the conditions of the new specification of the American Society for Testing Materials, which reads as follows:

"The temperature of the room, the materials, the mixing water, the moist closet and storage tank water shall be maintained as nearly as practicable at 21° C. (70° F.) and the mixing water, moist closet, and the water in the storage tank shall not vary from this temperature more than 3° C. (5° F.)."

This is a much more rigid requirement than that in the older specification, which stated that the air and water should be maintained as nearly as practicable at a temperature of 21° C. (70° F.) and did not give a definite tolerance limit. Testing laboratories may find it necessary to install new equipment to meet the new conditions. In the northern states the problem is to maintain the necessary amount of heat in the fall and spring, while in the southern states the greatest difficulty is in reducing heat in summer.

In designing a moist closet for New Hampshire conditions the following features were considered:

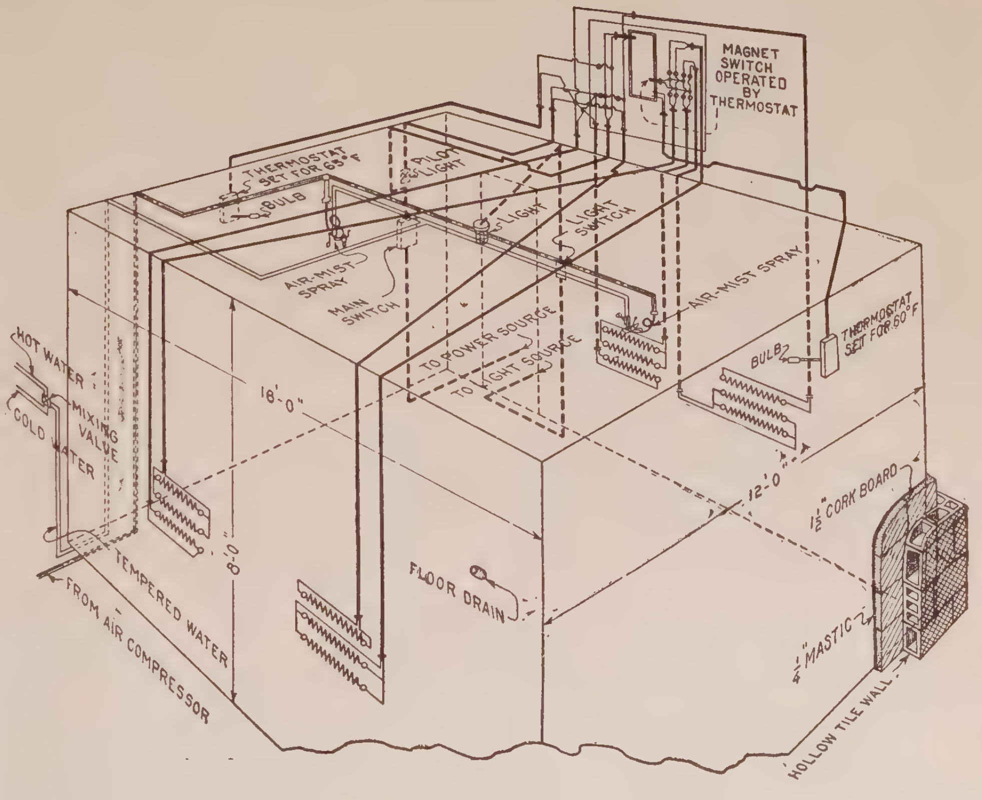
1. Insulation against heat and cold.
2. Equipment to generate and control the necessary heat.
3. Equipment to maintain the maximum degree of humidity.

The closet sidewalls were constructed of 6-inch hollow tile and lined with 1½-inch cork board coated with a bituminous mastic one-quarter inch thick. The cork board was cut into slabs 12 by 36 inches in size and cemented to the tile by a rich cement-sand mortar. The cork was treated with a chemical sealer to prevent staining by the mastic. Three coats of a cement-stucco paint were applied to the mastic coat after the wall-board was placed. The room has been in operation for three months and there is not the least sign of the mastic causing discoloration. The floor is made of concrete, and the top of the closet is constructed of 4 inches of reinforced concrete. The door is of wood and is lined with cork. This construction has been found to give entirely satisfactory insulation.

Two possible sources of heat were considered, steam from the heating plant of the building and electricity. It was decided that steam heat could not be regulated satisfactorily, while electric heating could be easily controlled, and in addition would be available at all times, although more costly.

The heating units used were 500-watt capacity heaters.

Public Roads



Sketch showing arrangement of temperature and moisture controls for moist closet

Four of these were connected in series and eight in parallel. The series group was connected to a liquid-type thermostat set at 65° F. and the parallel group was connected to a similar thermostat set at 60° F. The latter were wired through a 110-v., 60-amp. remote control switch. But little use has been made of this group as the temperature has not fallen to the point where it comes on. Figure 1 shows that the heating units are arranged in four groups, each consisting of one of the units in series and two of those in parallel. It is necessary that the heating units, switches, thermostats, and connections be of the best type and not affected by corrosive action in the warm humid atmosphere. These heaters require considerable current and it is necessary that the wires and insulation be of the very best. The main feed consists of No. 6 rubber-covered wire while all outside wiring is No. 4 common covered wire. Owing to the excessive heat and dampness, the wires connecting the fuse block and control switch are No. 14 and of the slow-burning type.

At the present time a recording thermometer has not been installed and it is necessary to take readings at different periods of the day. Typical observations covering a week have been recorded as follows:

	Temperature in Degrees Fahrenheit		
Date	8:30 a. m.	12 m.	5 p. m.
Nov. 15	68.7	66.9	66.9
Nov. 16	66.2	68.5	70.1
Nov. 17	70.1	68.9	67.5
Nov. 18	65.7	68.0	68.0
Nov. 19	67.1	69.1	67.1
Nov. 20	66.9	67.1	-------

Equipment to Maintain Humidity

Two humidifiers supply a very fine fog spray. They are connected with water and compressed air. By adjustment it is possible to get nearly any degree of humidity required. During the fall and winter the water is very cold. Unless it is tempered somewhat by the use of warm water and a mixing valve there is a great demand on the heaters to keep the room to the desired temperature. The purpose of the mixing valve is simply to reduce the expense of operating. The heaters will keep the temperature up, however, if tempered water is not introduced. The humidifying apparatus also serves to keep the atmosphere in the chamber in constant motion and at a uniform temperature throughout.

Pans for the storage of briquettes, and 2 by 4-inch cylinders have been installed in this room. The pans are arranged in such a manner that a small trickle of water empties into a holding tank which allows the water to come to the temperature of the room and the water overflows into a pan in which briquettes are stored. In the second pan there is an overflow pipe which empties into another pan below. Five pans, including the storage pan, are placed in this way and are supported by a frame made of angle irons, the joints of which have been electrically welded. This was done to avoid the rusting of screws, bolts, and washers. Two pans much longer and deeper than the one described above are used for the storage of cylinders. The room is large enough to store all the concrete cylinders the laboratory will be called to test.

A large stock bottle of distilled water for mixing is kept in this room at all times. Enough is drawn off for each test and as a result the requirement of keeping the mixing water within the tolerated limits can be carried out. Immediately upon making the pats for initial and final set and for the steam test they are placed in this room upon a slate-covered bench and are kept there during the period required.

Block Manufacturers Get Label and Inspection Service

As a result of fire tests and related studies on concrete building blocks conducted by the Underwriters' Laboratories at Chicago, a label and inspection service has been established for this type of building unit. Manufacturers of concrete building blocks are now obtaining listing as producers of standard products conforming to specifications developed from the laboratory research.

The service, which has been in operation some time, and which has been adopted by a number of manufacturers, is doing much to improve the general standard of quality of concrete building block.

Under the label and inspection service, the names of concrete block manufacturers making products conforming to the specifications are carried in published records which reach the various inspection and rating bureaus and insurance companies. A small metal label identifies the products of these manufacturers, distinguishing them from the non-inspected product. Special fire insurance rates have been granted in the states under the jurisdiction of the Southeastern Underwriters' Association, including Florida, Georgia, Alabama, North Carolina and Virginia. Louisiana also has granted special rates. In the East, New York State and Philadelphia have given special insurance rates to the labeled block and it is expected that other eastern states will soon follow in New York's lead.

A standard inspected product will do much to improve the general quality of concrete blocks. Where special rates have been granted, manufacturers will find it greatly to their advantage to come in under the inspection service. In communities where there are no building codes, the buyer who has no other means of ascertaining a quality product is very glad to get inspected blocks which he can be reasonably sure are standard. Such a product is worth more to him, and indications are that the label inspection service will be popular in such communities.

As is customary when the Underwriters' Laboratories establish a new inspection service, the initial cost is not set, but may vary according to the number of manufacturers who take the service. The total cost for first inspection and testing should not exceed $75 for manufacturers making block found acceptable at the first inspection, and this amount will very likely be reduced. The cost of the inspection service after the block has finally been approved by the laboratory is $2 per 1,000 labels. This, too, may be reduced later. This charge covers the cost of making the labels and conducting inspection of the blocks at frequent intervals.

To get the new underwriters' service, the manufacturer, when applying, states the shape, size, strength and quality of the block he puts out. If this conforms to the standard block of the laboratory, a representative is sent out to inspect the plant. The laboratory then conducts a chemical test of aggregates, and tests the block for compressive strength. After label service has been established the tests are repeated from time to time to assure maintenance of the standard.

Cast Stone Plant

A plant for the manufacture of cast stone trim and architectural cast stone is planned by the Arnold Stone, Brick & Tile Company, Jacksonville, Florida. The size will be 100 x 230 feet, to cost $30,000. A daily output of fifteen tons is planned.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 2970 West Grand Blvd., Detroit.

American Concrete Pipe Association; M. W. Loving, Secretary, 33 W. Grand Ave., Chicago.

American Construction Council; Dwight L. Hoopingarner, Executive, 28 W. 44th St., New York City.

American Engineering Standards Committee; Dr. P. G. Agnew, Secretary, 29 West Thirty-ninth St., New York City.

American Road Builders' Association; Chas. M. Babcock, President; Miss E. A. Birchland, Secretary, 29 W. 39th St., New York City.

American Society for Testing Materials, C. L. Warwick, Secretary-Treasurer, Engineers' Club Building, 1315 Spruce St., Philadelphia, Pa.

Associated General Contractors of America; D. H. Sawyer Secretary, 1150 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; 123 West Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference of America: H. E. Plummer, President; Fred W. Lumis, City Hall, Springfield, Mass., Secretary.

Concrete Reinforcing Steel Institute; M. A. Beeman, Secretary, Tribune Tower, Chicago.

Concrete Products Association; S. I. Crew, President, Norwood, Ohio; Austin Crabbs, Secretary, Box 343, Davenport, Iowa.

Iowa Concrete Products Association; Floyd Goodrich, President; R. L. Gavin, Secretary-Treasurer, 405 Hubbell Bldg., Des Moines, Iowa.

National Association of Building Trades Employers; A. E. Coleman, President; A. W. Dickson, Executive Secretary. 2226 Builders Building, Chicago, Illinois.

National Association of Builders' Exchanges; William F. Chew, Baltimore, President; Earl F. Stokes, Secretary, 15 East Fayette St., Baltimore, Md.

National Crushed Stone Association; J. R. Boyd, Secretary, 751 Earle Building, Washington, D. C.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East Twenty-second St., New York City.

The National Lime Association; G. B. Arthur, Secretary, 927 15th Street, N. W., Washington, D. C.

National Slag Association; H. J. Love, Secretary-Treasurer, 933 Leader-News Building, Cleveland, Ohio.

National Sand and Gravel Association; V. P. Ahearn, Executive Secretary, 432 Munsey Bldg., Washington, D. C.

Nebraska Concrete Products Association; A. V. Anderson, President, Reimers-Kaufman Co., Lincoln, Neb.; E. L. Bateman, Secretary, Bethany, Neb.

Ohio Concrete Products Association; G. M. Friel, Secretary-Treasurer, 2284 North High St., Columbus, Ohio.

Portland Cement Association; William M. Kinney, General Manager, 33 West Grand Ave., Chicago.

Rail Steel Bar Association; H. P. Bigler, Engineering Secretary, Builders' Bldg., 228 N. La Salle St., Chicago, Ill.

Wisconsin Concrete Products Association; A. P. Kuranz, Secretary-Treasurer, 425 E. Water St., Milwaukee.

Mixer Musings

Reported by "Joe"—The Mixer Boss.

Slump Testers Wanted

The fellow they call the editor on this here sheet puts my stuff toward the back all the time, but that doesn't mean it's no good. I'll wager you a sack of gray matter that right now you're reading the best part of the paper. That may not be what the boss thinks, but it's my opinion.

If nobody else pats a fellow on the back once in a while, he can yodel it himself just as good, I guess.

Now, what's the matter with you fellows on this side of the water, in these United States, the home of the slump test? Here I'm getting applications right along from Europe. You're way behind over here. Wasn't that a dandy that I printed for you in the last issue and the one before that? It cost those boys a little more postage than the two cents you'd have to spend to get in this "400" of the water barrel.

And did you see that letter I printed from Bill, not so long ago come over from his Italy? It's fellows like him that make good.

If they keep on coming in like they have been, maybe I'll start a branch office in Europe. Then if I'd go over there I'd sure join the Ancient Order of Froth Blowers in England that Mr. Worsdale wrote us about. It's something we can't ever start over here, unless they change one of the laws we've got here. (I think I'm going to investigate this foreign branch business.)

So far I've been able to translate all the applications from Europe; I haven't struck a stickler yet and here's hoping for the future. I'll try my hand at anything, except maybe if a One Bad Lung sends his in.

As I've said here before, the Guild of Certified Slump Testers is open for membership to the man who can convince the committee on members that he's telling the truth about how he made his first slump test.

I know a fellow doesn't always have the time he'd like to to write a long letter. Your application doesn't have to be a long letter. You can make it as short as you want. Hope the editor doesn't see this, but with winter coming along, most fellows have a little more time on their hands. (The editor says "Every season sees an increasing amount of winter construction.") Hope the movement hasn't gone too far, because *I* want to *see* a lot of letters coming in, and I figure a little extra spare time will help them get started.

If you don't want me to print your letter here, I won't. But why be *too* exclusive?

Anyhow, get your degree of C. S. T.! Be one of the honored men in your profession.

One fellow couldn't see the profit in paying men to take the shavings and sawdust out of the bottoms of the joist forms, but he paid real cash to put on half of his fireproofing with the trowel. A few brooms and shovels, or another air-compressor, would have saved some of his expected profits.

Joe, the Mixer Boss.

New Equipment

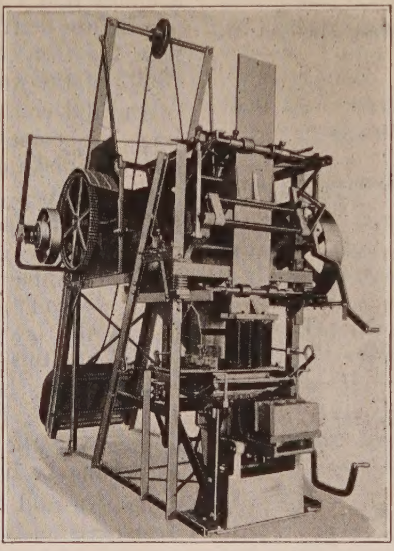
Besser Has New Low-Price Semi-Automatic Block Machine

The Besser Sales Company, Chicago, has entered the low-price field, with a face-down block and tile machine having the standard of durability of its larger machines. All regular sizes of products may be made, using but one size of wooden or steel pallet.

Production is largely dependent upon the operator, since the machine is not fully automatic. Machines now in the hands of owners have produced around 1,400 block a day. The average daily capacity is rated at 1,000 to 1,200 block. Either panel or regular face block may be made at the same rate of speed.

The single bar tamper assembly weighs 400 pounds, more than is usual in a machine of this price. It has an average drop of 12 inches.

Six-inch guides extending above the feed box practically eliminate wastage and spillage when the incremental feeder is operated. The feed box is quickly removed by releasing two rods.

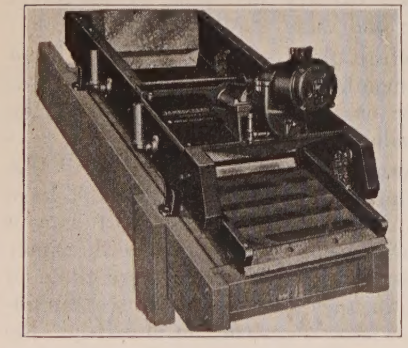


Grease cups that are handy to reach and quickly filled provide for proper lubrication. One filling every two weeks is sufficient.

James Screen Efficient

As the development of a mechanical and metallurgical engineer, the James screen, for wet or dry materials, presents some changes in screen design that have proven efficient.

A thirty-pound ram operating against a heavy piston at 300 revolutions per minute, each of its six chilled steel sockets colliding with the hardened steel contact points of the piston, give the latter member 1800 head-on collisions per minute. These repeated shocks transmitted to the screen force all material through the meshes, keeping the screen from blinding and giving uniform vibration over its entire surface.



The screen frames are built in sections, which are interchangeable.

When using the wet process for screening material finer than 3/16-inch, auxiliary washing trays located every two feet across the screen area disintegrate the accumulation of mud balls. By the addition of a sufficient amount of wash water, fine grains are forced through the meshes with great rapidity.

The Norwood Engineering Company, Boston, Mass., is the manufacturer.

Electric Rotary Floor Surfacing Machines Successful

If a description of a piece of equipment new to the field is of interest, one of a product that has passed the test of 20 years' of usage successfully is doubly interesting.

Some 20 years ago the Electric Rotary machine was placed on the market by the Electric Rotary Machine Company, 3825 West Lake Street, Chicago, Illinois. This combined machine grinds and polishes cement, terrazzo and mosaic floors. Cement floors are smoothly finished and given a polished surface, at a rate which equals the work of 10 to 12 men. Floors that are worn down or damaged by frost, rain or other similar causes may be resurfaced by this machine.

In the surfacing and polishing of mosaic and terrazzo, approximately 325 to 400 square feet per day can be ground to a fine degree of uniformity.

The motor is built especially for its job and is horizontally installed. Bearings are packed in hard oil. Construction of the machine is such as to avoid top heaviness.

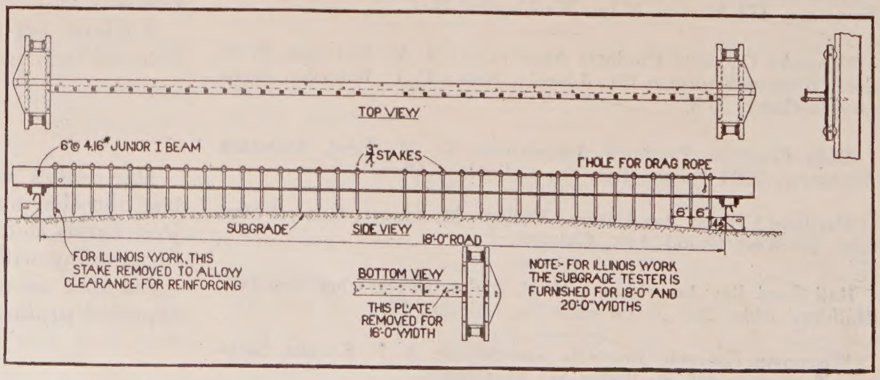
Other uses to which the Electric Rotary machine may be put are the surfacing and polishing of marble, sandpapering, refinishing of old wood floors, waxing and polishing and scrubbing.

The Giant Grinder, another product of the same firm, is a larger machine, with double rotating discs and a capacity of 100 square feet per hour.

Subgrade Tester Follows New Standards

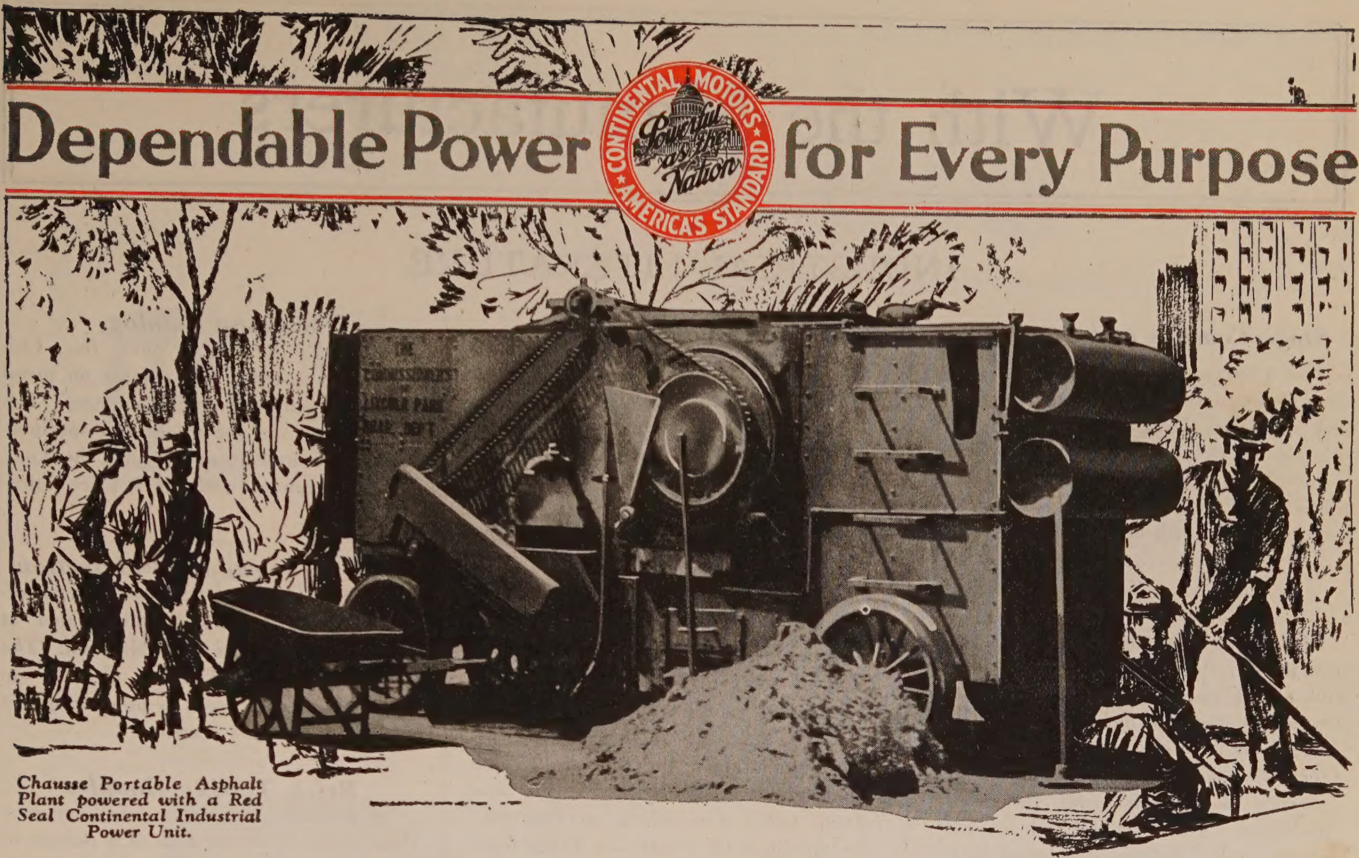
Standards recently adopted by the Pennsylvania State Highway Department have been followed in the design of the new subgrade tester being made by the Lakewood Engineering Company, Cleveland, Ohio.

The tester is used to check the subgrade just before the concrete slab is placed. It is adjustable for two widths, either 16-18 foot or for 18-20 foot roads. The pins may be set to any cross section wanted.



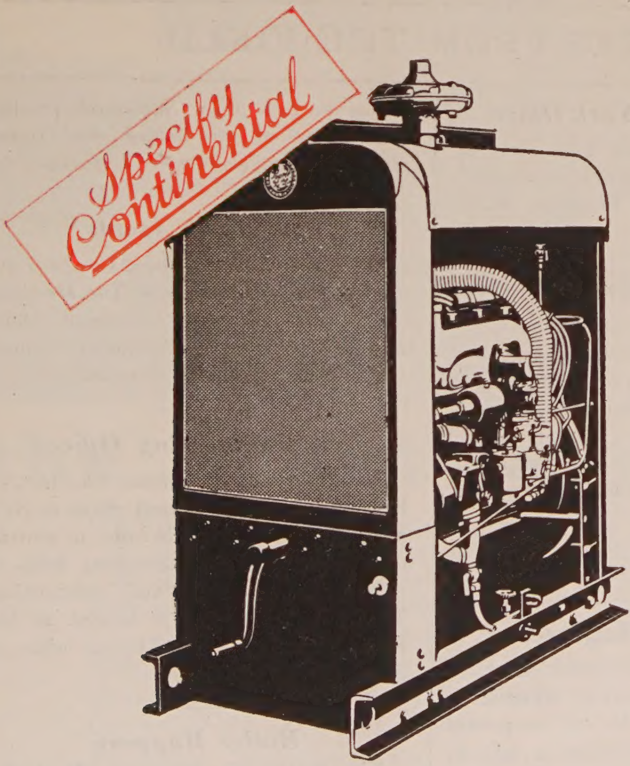
TOP VIEW
6" @ 4.16# JUNIOR I BEAM
3/4" STAKES
HOLE FOR DRAG ROPE
6"
6"
4 1/2
SUBGRADE
SIDE VIEW
18'-0" ROAD
FOR ILLINOIS WORK, THIS STAKE REMOVED TO ALLOW CLEARANCE FOR REINFORCING
BOTTOM VIEW
THIS PLATE REMOVED FOR 16'-0" WIDTH
NOTE:- FOR ILLINOIS WORK THE SUBGRADE TESTER IS FURNISHED FOR 18'-0" AND 20'-0" WIDTHS

Dependable Power for Every Purpose



Chausse Portable Asphalt Plant powered with a Red Seal Continental Industrial Power Unit.

An Unswerving Policy of Concentration



Over a period of 26 years Continental have held to an unswerving policy of concentration on gasoline motor building.

Hewing closely to a well defined line all these years has resulted in the maintenance of the high quality and consistent performance characteristic of every Red Seal Continental motor. This experience, plus unsurpassed facilities, are two of the reasons for Continental leadership in the heavy duty industrial gasoline power field.

CONTINENTAL MOTORS CORPORATION
INDUSTRIAL EQUIPMENT DIVISION
Office and Factory: Muskegon, Michigan
The Largest Exclusive Motor Manufacturer in the World

Continental Motors

With the Manufacturers

INDUSTRIAL LITERATURE

Stage Coaches and Conveyors

The Cleveland Electric Tramrail Division of the *Cleveland Crane and Engineering Company,* Wickliffe, Ohio, uses and illustrates the term *"Stage-Coaching Through the Factory"* to compare the inefficiency of constant changing of conveyors in a plant with one of its systems.

M & M Products

M & M wire, splicing and column clamps, adjustable shores, sheeting darts, and screed gauges, as well as wire cutters and nippers are included in a catalog just received from the *M & M Wire Clamp Company,* Minneapolis, Minn.

Several useful tables for the proper spacing of column clamps and for wall, column, and slab forms are found in the back of the book.

Silicate of Soda Cements

One of a series of bulletins describing silicate of soda and its uses and published by the *Philadelphia Quartz Company,* Philadelphia, Pennsylvania, is devoted to silicate of soda cements. Directions for its use in refractory units including furnaces, linings, and chimneys, are given and illustrated.

Steel Institute Publication

How a story every eight days was made on a large apartment building of irregular outline in Washington, D. C., is told by a file sheet published by the *Concrete Reinforcing Steel Institute,* Chicago.

List of Laboratories

A valuable book of industrial research laboratories, No. 60, has been published by the National Research Council, Washington, D. C. It is a revision of a list originally published in 1920 and contains approximately 1120 listings.

The alphabetical list of laboratories includes the firm name, address, research staff, including the name of the director and the number of his assistants, followed by the amount of time devoted to research, and the subjects investigated.

Lists follow of addresses of directors of research, then geographical distribution of laboratories, and subject classification of laboratories.

Form Clamp Catalog

The new 48-page catalog of the *Universal Form Clamp Co.,* 972 Montana St., Chicago, Ill., contains a number of charts and tables on design of wall and slab forms and other data. Copies will be sent on request.

Wheel Load Formulas

Formulas for the transmission of wheel loads to culverts through various thicknesses of cover are included in *Bulletin 79,* an 80-page illustrated bulletin published by the *Iowa Engineering Experiment Station* under the title of *"Experimental Determinations of Static and Impact Loads Transmitted to Culverts."* The bulletin is the result of a 3-year highway research investigation conducted at Ames, Iowa, in cooperation with the United States Bureau of Public Roads.

Ryerson Catalog

Joseph T. Ryerson & Sons, Inc., Chicago, have issued a new catalog on metal working small tools and machinery. The catalog gives the list prices and specifications. The supplement provides the f.o.b. points, discounts, and other price information.

Georgia Cement Publication

The Georgia Portland Cement Corporation, recently organized and located at Augusta, Georgia, in its publication, *"The Georgia Portland Cement News,"* announces that it is soon to produce quick-hardening portland cement.

Brick Testing Booklet

"A Portable Apparatus for Transverse Tests of Brick" is the title of a *Bureau of Standards* publication, written by *A. H. Stang,* Engineer. A small charge is made per copy.

NOTES FROM THE FIELD

Blaw-Knox New York Office

The address of the New York office of the *Blaw-Knox Company* has been changed to the Canadian Pacific Company Building, 342 Madison Avenue.

"General-Akron"

On September 1 the *Akron Barrow Company* became the *General Wheelbarrow Company.* Since 1921 its products, including concrete carts, salamanders, mortar boxes and scrapers, have been manufactured in Cleveland, so that the former name seemed inappropriate. The firm has been in business since 1840.

The line of merchandise will be known as the *"General-Akron."*

New Cincrete Engineer

Wallace R. Harris has joined the *Cincrete Products Corporation* at Milwaukee, Wisconsin, as engineer. He will co-operate with engineers and architects in solving concrete construction problems in which *Cincrete* units are employed.

Lewis-Shepard Branch

The Lewis-Shepard Company, Boston, Massachusetts, has established a branch factory at West Bend, Wisconsin, for the manufacture of arc welded steel frame platforms to supply western territory.

Lakewood Agents

The Lakewood Engineering Company announces the appointment of *The Mechanical Supplies Company,* Cincinnati, Ohio, as a new agent in the Cincinnati territory and adjacent Kentucky counties.

New Engineering Offices

The Thompson & Lichtner Co., Inc., of Boston, has recently opened offices in New York City and Chicago in order to provide closer contact in the engineering fields of management, research and construction. The New York office is located at 551 Fifth Avenue, and the Chicago office at 208 South LaSalle Street.

Butler Hoppers

The Butler Bin Company, Waukesha, Wisconsin, have just issued a bulletin, No. 150, under the title of *Butler Weighing Hoppers.* This is a 12-page bulletin profusely illustrated, and describes in detail the method of proportioning aggregates by weight.